ELECTRICAL REVIEW

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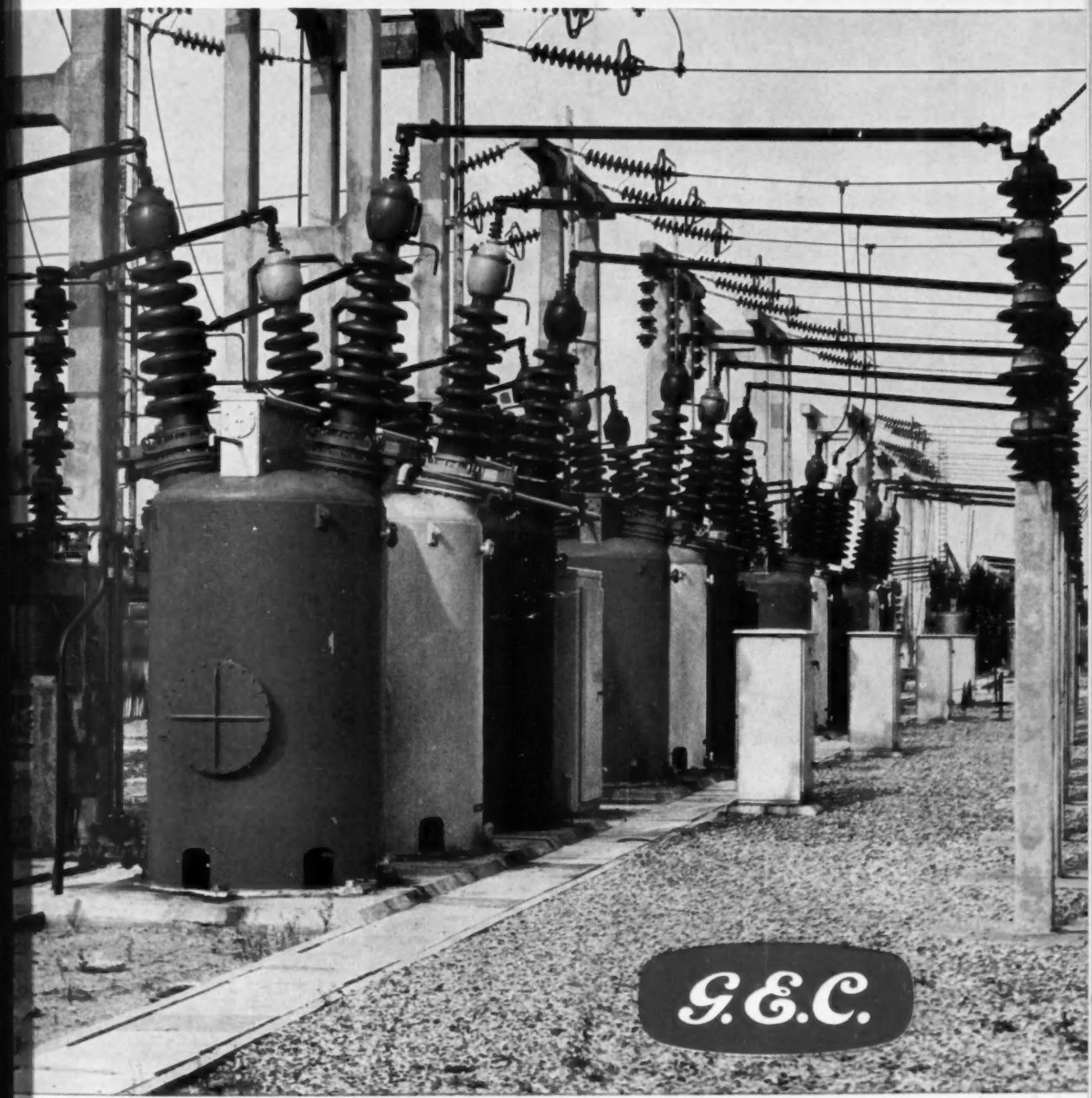

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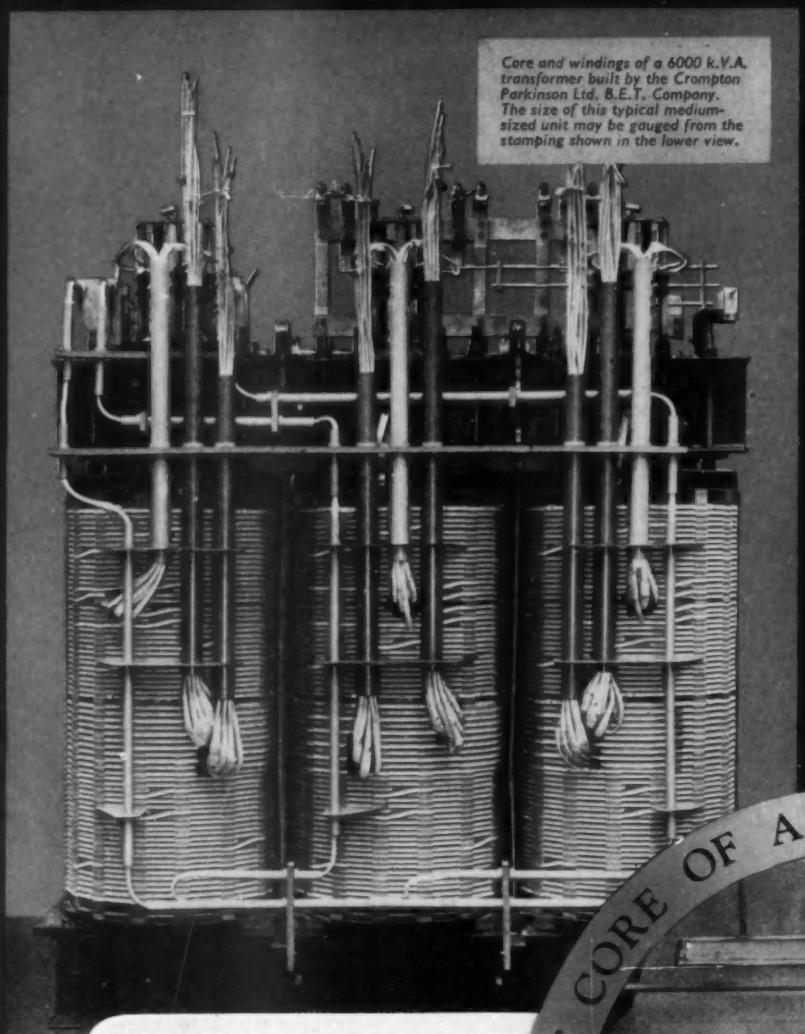
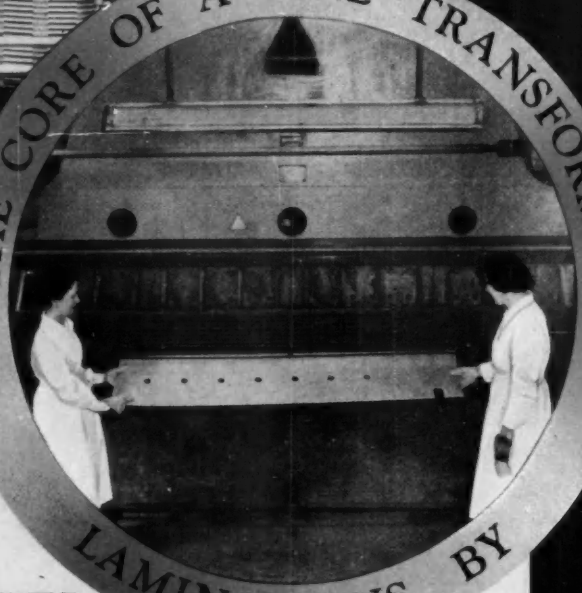


Core and windings of a 6000 k.V.A. transformer built by the Crompton Parkinson Ltd. B.E.T. Company. The size of this typical medium-sized unit may be gauged from the stamping shown in the lower view.

THE CORE OF A FINE TRANSFORMER



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ELECTRICAL REVIEW

27 November 1959 Vol. 165 No. 16 Established 1872

Cable Industry Troubles

EXCESS capacity and the lack of mutual trust in the industry following the break-up of trade associations are given by Mr. W. H. McFadzean (B.I.C.C.) as the main reasons for the position in which the electric cable industry finds itself today. For many years the cable-making industry was a very prosperous and expanding one and it naturally attracted a number of newcomers. The older companies, linked together by the Cable Makers' Association, had set a standard of quality which, they claimed, could be maintained and improved only by continuous research and development. This was costly and justified the rather high prices charged. They also claimed that others coming into the industry secured the benefit of the experience of the C.M.A. members without having to go to the expense of setting up large research departments.

The Monopolies Commission, which in 1949 was asked by the President of the Board of Trade to investigate the industry, recognised the part played by the C.M.A. companies in establishing the reputation and the export trade of the British cable industry. Nevertheless it came to the conclusion that the C.M.A. and the associated Covered Conductors Association operated so as to restrict competition. The Commission said in its report that although a common price had been a leading feature of the two associations' systems, they claimed with truth to be something much more than price rings. " Both associations have established minimum standards and insist on a high level of quality." Nevertheless the Commission would not accept the contention that " price competition would necessarily prevent the continuance of valuable co-operative work on standards and research."

It recommended that common price agreements, special rebates and arrangements for sharing business should be ended, although it was not against the fixing of minimum prices under certain conditions. The Government accepted the recommendations in 1954 and the cable makers eventually complied with them. Later on the Restrictive Trade Practices Act was passed and in due course it was announced that cable price agreements had been terminated.

The excess capacity mentioned by Mr. McFadzean has arisen from several causes, two principal ones being the before-mentioned influx of " newcomers " and the falling-off in orders from abroad, due to the establishment of their own cable factories by former overseas customers (in which

our home companies have assisted). Cable exports last year were only £26·4 million, against £36·4 million in 1957.

One main consequence of these developments has been the absorption of some companies by larger groups or arrangements between companies. The smaller cable companies are naturally perturbed. Mr. L. S. Hargreaves (chairman of Aerialite, Ltd.) has alleged that in pursuance of a "monopoly" policy there has been under-cost selling by some makers. As to this, Mr. McFadzean has said that the lead given by B.I.C.C. to determine prices on "a basis which would show a reasonable return to an efficient producer" had not been followed. As a result the prices of l.v. mains cables and general wiring cables had been reduced by uneconomic competition. [This week B.I.C.C. announced a 7½ per cent increase in the price of its l.v. mains cables.]

It is very regrettable that an industry which once led the world should have fallen into such a state—and in some ways incomprehensible. All over the world, and not least in our own country, the use of electricity continues to expand. Is the productive capacity permanently or merely temporarily excessive? Must "rationalisation" result in monopoly or can the independent firms survive? We do not believe that the large groups possess all the ingenuity in technical development and efficient production and we see dangers in allowing the process of amalgamation to go too far.

THE A.E.I. STRUCTURE

Lord Chandos announced this week that the reorganisation of Associated Electrical Industries, Ltd., would be completed by 1st January next. He was giving particulars of the change of name of the principal subsidiaries which have now become managing companies of the new Product Divisions.

Details of the changes are given in this issue. Many will regret the disappearance of familiar (and indeed famous) names which results from the reorganisation, but on plant in this country and all over the world old nameplates will serve as a reminder for many years to come.

COUNTRY AMENITIES

The problem of land shortage in this country is daily becoming more acute, for as industry and housing steadily expand the public is becoming increasingly aware of the need to preserve the remaining countryside for agricultural and recreational pursuits. A situation is arising in which the majority of the areas not yet subject to industrial development, although entirely suitable, can lay claim to features which may be of sufficient historical, geographical or scientific interest to justify their exemption. The electricity supply industry, in meeting the growing national demand for power, needs more land for power station construction and a more extensive transmission line network and, although the difficulty of land acquisition is not peculiar to the C.E.G.B., the Board is one of the country's largest industrial constructors and accordingly receives a large amount of public criticism.

Two papers, briefly summarised elsewhere in this issue, were presented this week to the Royal Society of Arts on power production and transmission in the countryside and the preservation of rural amenities. Prepared by Sir Christopher Hinton, chairman of the C.E.G.B., and Sir William Holford (Professor of Town Planning at University College, London), a part-time member of the Board, they dealt in a well-balanced manner with both the needs of the Board and the widely felt desire to preserve amenities. Some form of compromise between the rival claims of essential power and natural beauty will obviously have to be found. Technical advances such as high capacity transmission lines to reduce the degree of development required, and improved appearance design of the various installations to minimise the disfigurement caused are but two of the methods which can be used.

LARGE TURBO-GENERATORS

In this issue a brief description is given of the plant which is to be installed in the projected Drakelow "C" power station. Initially, two single shaft 350 MW turbo-generators are to be installed and these have been ordered from the English Electric Co., Ltd. They are the largest machines of this type so far ordered in this country and represent a significant stage in the company's policy to continue the development of the large single shaft, single alternator unit. This policy results in increased economy in fuel consumption, in unit cost, in space and in operating staff.

The new station will be built on the Drakelow site alongside the "A" and "B" stations which have capacities of 240 and 480 MW respectively. When the "C" station is complete the site will have a total output of well over 2,000 MW, which will make it one of the most important centres of base load generation in this country. As the site is a focal point in the supergrid system it is unlikely that any further overhead transmission lines will have to be constructed.

PRACTICAL TRAINING

The importance of the initial training of any professional man cannot be overstressed. Since neither his career nor developments in his particular sphere can be predicted, practical training should be as broad as possible. When a candidate applies for election as an associate member of the Institution of Electrical Engineers, the report of the training he has undertaken is carefully examined. To clarify the position, the Institution produced two booklets dealing with the training of graduates and the education and training of student apprentices. These booklets outline the type of training acceptable to the Council.

The I.E.E. has now issued "Training Regulations," published under the authority of the Council and a note of its contents appears in this issue. Included in the Regulations is a form for submitting a statement so that the nature of the training can be assessed. This form is for the use of graduates after they have completed their training and, if this training conforms with the Regulations, the fact will be registered, otherwise the graduate will be notified of the extent and nature of the deficiency. No doubt, this will be of assistance to the young engineer, but he would be well advised to consult the Institution before undertaking any particular training course, to ascertain its worth.

Cooling of Large Power Transformers

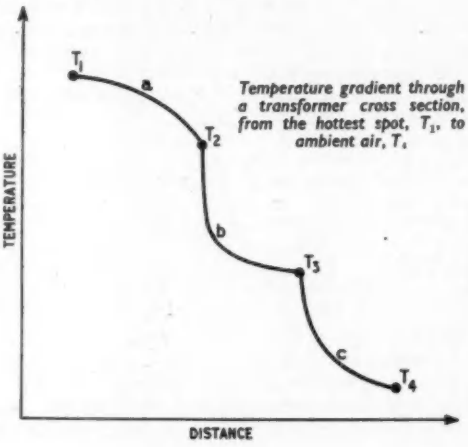
By G. O. CASTELL, M.I.E.E.*

Although modern transformers operate at very high efficiencies, losses in the form of heat still have to be dissipated. In this article the author, after referring to the penalties of excessive temperature rise and to the location of high temperatures within a transformer, surveys the methods currently employed using both natural and forced oil and air circulation for cooling large units

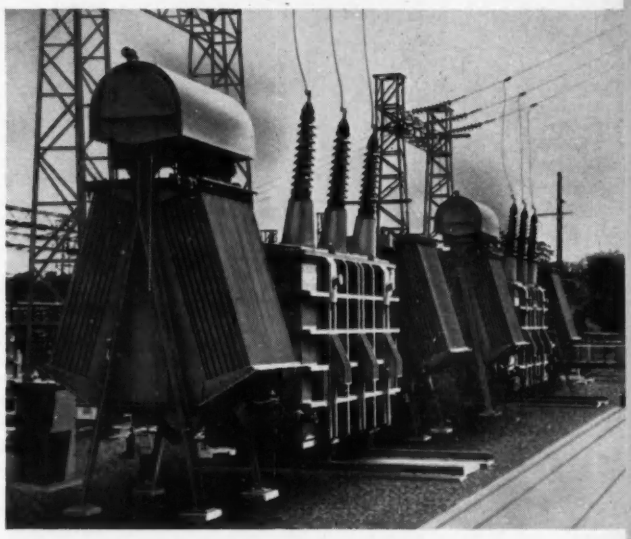
ANY transformer of 10 MVA capacity or over, if it is of normal design, will have an efficiency of 99 per cent or better. Even so, losses amounting to hundreds of kilowatts, all manifested in the form of heat, occur in single units and these must be dissipated efficiently so that no part of the transformer reaches a damaging temperature.

Operating temperature is by far the most important factor affecting the life of a transformer. The direct cause of a failure may be the impact of a lightning surge or the mechanical forces due to an external short circuit, but if the transformer is well designed and has passed all its factory tests it is unlikely to break down from either cause as long as the insulation remains in good condition. Cellular insulations, of which paper is the principal, form the bulk of those used in modern transformers and they all become brittle and rapidly lose mechanical strength at advanced temperatures. It is then that they become vulnerable to electrical or mechanical stresses.

A great deal of investigation has been carried out, particularly in America, into the behaviour of electrical grades of insulating papers maintained at various temperatures in oil, using tensile strength as a criterion. It is now generally accepted that at a continuously maintained temperature of 95 deg C transformer insulation will have a normal life, that is 20 to 25 years. The rate of deterioration is, however, approximately doubled for every 8 deg above 95 deg C and since it is at the "hottest spot" that a weak link will be developed it is easy to appreciate the importance of a carefully planned and properly monitored cooling system.



Temperature gradient through a transformer cross section, from the hottest spot, T_1, to ambient air, T_4



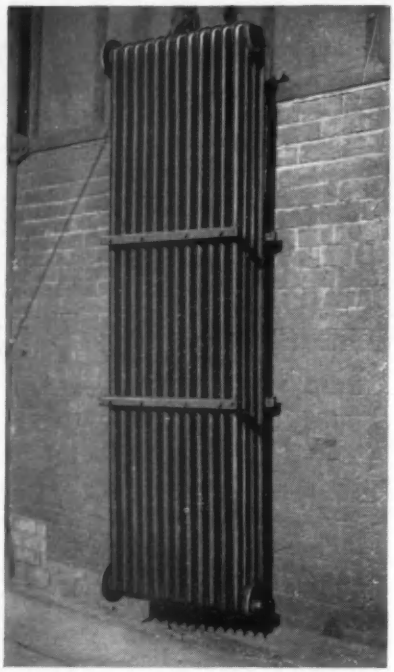
Separate coolers are fitted with fans to provide ON/OB cooling on these 30 MVA transformers

A hot-spot temperature indicator is essential to the operation of a large transformer, in which it may be set to bring in extra cooling, give an alarm or trip a circuit-breaker at any predetermined temperature. Most hot-spot indicators are fitted with two sets of auxiliary contacts so that the transformer user may choose a combination of any two functions.

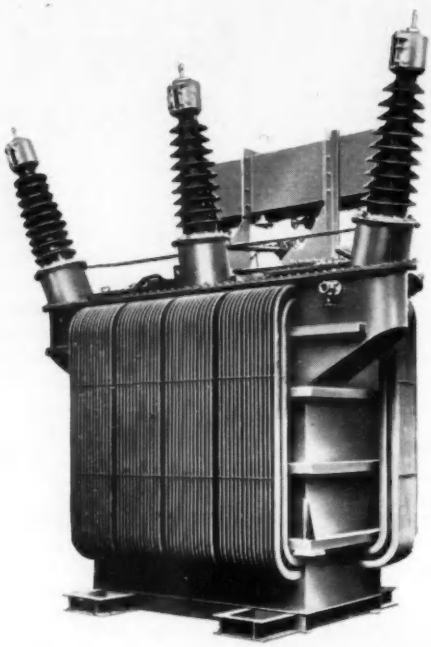
Of the losses in a transformer at least 80 per cent will be copper losses, and cooling of the core, although, of course, it must be properly planned, rarely presents any problems to the designer. The heat due to copper losses is generated throughout the windings, but the designer is chiefly concerned with getting it away from the situation at which he estimates the hottest spot will occur.

The graph shows in diagrammatical form—no scale is attempted—the temperature gradient from the centre of a coil to the cooling medium in a naturally-cooled transformer, that is, when the circulation of both the oil and the air is due to the thermal head developed by the transformer itself. The value T_1 is the temperature rise in the centre of a coil and the gradient *a* is the conduction drop through the various thicknesses of included insulation to T_2 which is the temperature rise at the surface

* Hackbridge & Hewittic Electric Co., Ltd.



Radiator of welded pressed steel construction



1,000 kVA ON cooled transformer with elliptical tubes welded around the tank perimeter

of the coil. This gradient must be controlled by efficient coil ducting; the amount of insulation included is largely dictated by the voltage of the winding, but in large transformers every conductor must be in contact with the oil. Gradient *b* is the temperature difference between T_2 and the average oil temperature at the same physical level, the temperature drop largely occurring over a film of oil less than one millimetre thick close to the coil. It is often referred to as the surface drop. T_3 is the temperature rise at the surface of the tank, again at the same level as that at which T_1 and T_2 are measured. Gradient *c* is the temperature difference between the surface of the tank and the ambient air temperature T_4, and again there is a pronounced surface drop.

When forced cooling is applied, either by pumped circulation of the oil or fan circulation of the air over the cooling surfaces, benefit is obtained by breaking up the surface films of oil and air respectively, achieving a considerable reduction in the gradients *b* or *c*. Thus, for the same temperature difference between T_1 and T_4 the gradient *a* can be increased, enabling the transformer to be uprated.

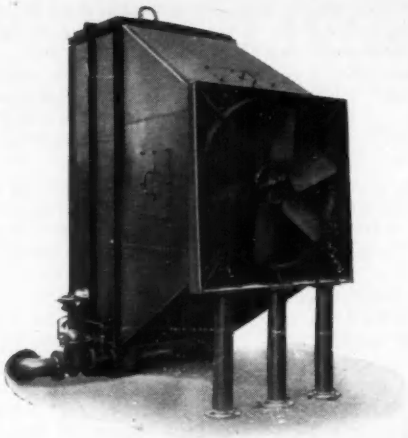
Temperature T_3 can be measured with a thermometer and if the bulb of the instrument is placed in the top layers of the oil it will indicate the maximum oil temperature rise when the ambient temperature is subtracted from the reading. No direct measurement of T_1 can be made except by inserting thermocouples into the windings, and although this has been done for research purposes it is not a practicable method to apply to normal transformers. What can be obtained on test, however, is the average temperature rise of the winding by the increase in resistance method described in B.S. 171. If the average temperature rise of the oil is obtained by taking the average of the temperature rises of the oil at the inlets and outlets of the cooling system, and this value is subtracted from the average winding rise by resistance, the gradient $a+b$ will be given. Note that this gradient is practically constant at all physical levels, from the top to the bottom of the winding. If this gradient, $a+b$, is added to the maximum oil temperature rise the temperature rise of the hottest spot will be very closely approximated.

A hot-spot indicator consists of an indicating thermometer situated in the hottest layers of the oil, and associated with it is a heater coil fed from the secondary of a current transformer connected in one of the terminal leads of the main transformer. Thus, the temperature shown is the sum of the top oil temperature and an amount proportional to the load on the transformer. The apparatus is adjusted so that under full load conditions the hot-spot indicator shows a gradient over the maximum oil temperature equal to the gradient $a+b$ obtained on test in the manner described above. If the heater coil is designed to have the same thermal characteristics as the main winding coils, that is the same time constant and the same wattage surface loading, then the hottest spot temperature reading will be correct over a wide range of transformer loading and ambient conditions.

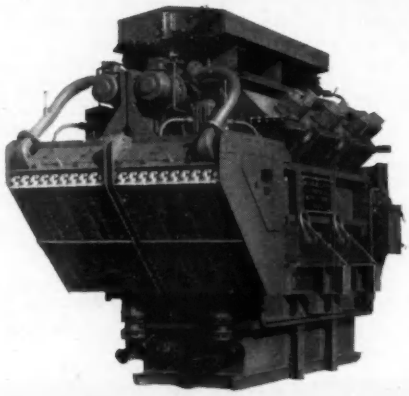
There are six systems of cooling defined in B.S. 171, and these are as follows:—

	Oil circulation	Cooling	Max. oil rise °C	Av. rise by resistance °C	Designation
1	Natural	Air natural	50	60	ON
2	,,	Air forced	50	60	OB
3	,,	Water	50	60	OW
4	Forced	Air natural	50	65	OFN
5	,,	Air forced	50	65	OFB
6	,,	Water	50	70	OFW

The ON type is normally economic for transformers up to about 15 MVA but it has certain advantages—simplicity, minimum of maintenance and quietness—which sometimes lead engineers to specify this form of cooling for larger units despite the extra capital outlay.



Individual OFB cooler



20 MVA transformer with built-on OFB coolers, one permanently operating, the second brought into use as required

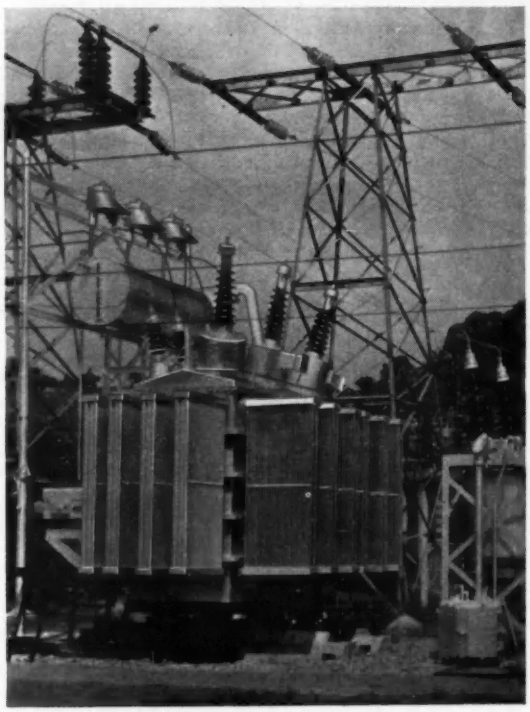
Most of the noise emitted by a transformer emanates from the core but fans and pumps contribute their share and nowadays, when both public and engineers are becoming very noise conscious, this aspect has to be considered when planning a transformer cooling system. In this respect it is usually found to be good practice to make the forced circulation, whether of air or oil, as slow as will achieve its purpose, but here as in so many engineering problems it is resolved into a matter of economics. Mixed cooling, in which a transformer has an ON rating—probably of about 50 per cent of the maximum continuous rating—and forced cooling switched in automatically when required by the loading, has the advantage of avoiding extraneous noise except when it is essential and this advantage is emphasised if, as is often the case, light load corresponds with the night-time. Maintenance is reduced, as is the cost of operation, since the forced cooling of a large transformer may require 20 kW of power. Another item to be considered in the economic balance is the cost of periodical repainting which, for comparable sizes, will be highest for ON transformers and lowest for OW or OFW. This point can be seen from illustrations.

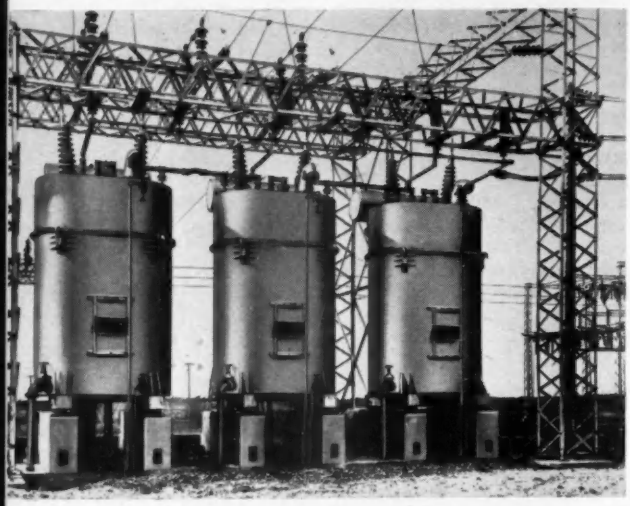
A large transformer, even if forced cooling is used, will require anything up to ten thousand square feet of wetted surface to dissipate its losses. This large area is obtained by circulating the oil through a number of tubes which may be round in cross-section though such other shapes as star, elliptical and waisted, for example, have been tried either to reduce the quantity of oil required to wet a given surface or to make possible the accommodation of a greater number of tubes in a given space. On transformers up to about 7·5 MVA, if a large part of the tank perimeter is free and not occupied by tap-change gear or cable boxes, the tubes necessary can be accommodated around the main tank itself, arranged in several rows if required. While increasing the cooling surface by adding rows of tubes increases proportionately the surface available for convection, very little is added to the surface for radiation, therefore the advantage gained is by no means proportional and it is rarely economic to arrange the tubes in more than four rows.

Radiator Coolers

There are in use many forms of coolers, loosely termed radiators, made by welding banks of tubes at the top and bottom into common headers, each header having one or sometimes two pipe connections to the transformer tank through which the oil circulates. Somewhat similar radiators are produced by welding together hollow-pressed steel sections and many of these bear a striking resemblance to an enlarged domestic central heating radiator. Radiators can be affixed to a transformer tank so that they project radially or they can be built into separate coolers. In either case they can be permanently welded into position, but it is more usual to make use of bolted flanges which often incorporate valves at both the top and bottom so that individual radiators can be disconnected without draining the main oil system. In this way transport is simplified and painting made easier.

10 MVA ON cooled transformer with elliptical tube radiators bolted to the tank side through valves at top and bottom





Three single-phase OW cooled units

The most simple way to apply forced cooling to a transformer is to blow air over the surface of the tubes, radiators or separate coolers, with one or more fans. If a low noise level is desired it is better to use many small fans than a few large ones, but this complicates the wiring and the control circuitry and again economics becomes the deciding factor.

Small fans may be arranged around the bottom of a tubular tank or between pairs of radiators, in which case the cooling efficiency can be improved a little by inclining the radiators together at the top to form an inverted vee. Separate cooler banks may be blown vertically or horizontally, and the latter method is gaining favour at the present time.

By inserting a pump in one of the main oil connections between a transformer and a separate cooler OFN cooling is obtained. When the pump is operating the load imposed upon the transformer can be increased by about 20 per cent, but if advantage is to be taken of the ON rating the pumps used must permit a free flow of oil when they are at rest. Care must be taken that an oil circulating pump introduces no air into the oil system and it is usual to use that type of pump in which both the pump and the driving motor run totally immersed in oil.

It is common practice to pump the oil between transformer and cooler without any further direction, but if full advantage is to be taken of this form of cooling the oil within the transformer must be controlled and directed over the coil surfaces. Cooling of the OFN type is not largely used by itself, but it has the advantage of being comparatively quiet.

Fan and Pump Combinations

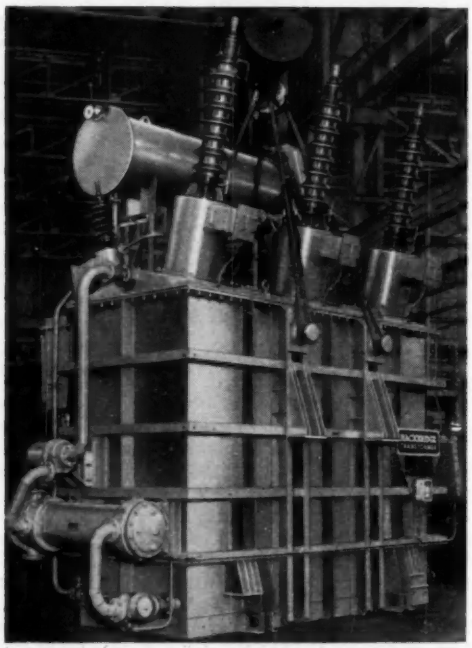
A combination of fan and pump applied to a separate cooler gives OFB cooling, a method having the advantage of giving a good natural rating to the transformer, and the pump and fan can be easily controlled separately or together. But the most economic way of applying OFB cooling is to use specially designed coolers, each with a built-in fan and pump, the oil being forced at high speed through a large number of small diameter tubes, generally finned on the outside to increase the efficiency of the air cooling, the whole assembled in a manner reminiscent of the conventional automobile radiator. Such coolers can have no natural rating and if this is desired an entirely separate ON cooler must be provided suitable for the losses up to the point at which it is decided to start the forced cooling system, commonly at half load.

In this country where water is a relatively expensive commodity it is not extensively used for cooling transformers, but it is a very good method and in those parts of the world where hydro power is freely available many transformers are so cooled.

In its simplest form water is passed through pipes situated in the hottest part of the oil, carrying the heat away to waste. The danger of water getting into the oil is one that must be guarded against. The cooling tubes should be of seamless copper, taken through the tank sides without a joint, all valves and meters being connected on the outside. The cooling system should be arranged to be self-draining in case the transformer has to be taken out of service in frosty weather. The amount of water required depends upon the temperature of the water which can be tolerated at the outfall; one-third of a gallon per minute per kW of loss to be dissipated will give a difference of 10 deg C between inlet and outlet water and this is generally acceptable. Using pipes having a 1in inside diameter the speed of water should not exceed 2½ft/sec and to obtain this on the larger sizes of transformer several tubes in parallel must be used.

With OFW cooling the oil is pumped from the main transformer tank through a nest of small tubes housed in a steel jacket through which the water flows. These coolers are self-contained, pumps, valves, flow indicators and sometimes measuring instruments being built in, and they are made in various sizes up to about 300 kW dissipating capacity. An OFW transformer can have no natural capacity of any sort and interlocks must be fitted to ensure that the transformer is not even excited without the cooler being in operation.

The oil pressure should be maintained a little higher than that of the water to ensure that, if a leak should develop in the system, oil will find its way into the water and not vice versa.



20 MVA OFW cooled transformer

VIEWS on the NEWS

By REFLECTOR

AS I expected, I have now heard about devices for keeping kettles simmering once the water has reached boiling point (see my note of 30th October). Mr. F. J. Allen, of Quarndon, Derby, says that in the late 1930's he had a kettle, of a well-known make, capable of doing this. It had a connector with four pins in square formation so that it could be inserted in four positions 90° apart. In either of the "180°" positions the loading was 1,800 W and in the other two it was 275 W. The kettle could be used as a double saucepan, an inner vessel being supplied with it. Mr. Allen says that in due course the body of the kettle became "peppered with holes" due to corrosion by the water but he adapted the element for use in another double saucepan which he still has.

* * *

Another letter comes from Merlin Mouldings, Ltd., London, S.E.6. It is accompanied by an illustrated leaflet describing a kettle immersion element. This is so designed that when the water is just below boiling point it is maintained in a simmering condition. When boiling water is required the connector has to be slightly withdrawn. The element (1,500 W) can be fitted into most types of electric kettles.

* * *

More fuss is made about electric "pylons" than about gasholders although there is no doubt about which are worse—or better. Unfortunately, except at terrific expense, it is not possible to substitute underground cables for overhead lines. In this respect the gas industry may eventually have an advantage if subterranean storage of gas, discussed at a meeting of the Institution of Gas Engineers, becomes common practice. Examples quoted were a natural gas storage reservoir beneath Paris and an experiment conducted by the Northern Gas Board in which 17 million cubic feet of gas was stored in rock salt excavations beneath the north bank of the Tees, with imperceptible leakage after a week. Unlike the electrical arrangements, underground storage of gas was said to be very considerably cheaper than the erection of gasholders.

* * *

I suggested in the 30th October issue that the National Coal Board would be better employed trying to encourage the sale of coal-generated electricity rather than smokeless coal. Earlier, in the local Press, the South of Scotland Electricity Board (Fife area) had used a similar theme, from a somewhat different aspect. In a page headed "1,000 miners' pay packets filled by Kincardine generating station" it was claimed that this new station was already consuming from 1,200 to 1,300 tons of coal a day (the product of a thousand miners) and would eventually use enough coal to maintain 6,000 miners and their families for years to come. In the same page there was an article giving examples of miners who live in (and like) all-electric homes. Later issues of the local newspaper carried advertisements headed "Electricity is Coal" and "Coal by Wire," emphasising the point that the Electricity Board is a good customer for coal and therefore by using electricity people benefit the coal industry—and, of course, themselves.

* * *

One source of trouble when there were about 600 separate electricity supply authorities was the disparity in charges in adjacent areas. It was natural for a consumer to complain that he was being charged 2d per kWh when (sometimes literally) a man across the road was paying only 1d. This was one of the things which nationalisation was expected to clear up and, of course, it has happened to a very large extent. Nevertheless, different Electricity Boards still have different charges. The matter has cropped up in Cambridgeshire where at a local meeting the National Farmers' Union reference was made not only to differences in charges for electricity, but also in connection charges. A recommendation from the Wisbech branch that all connection charges and tariffs should be standardised was approved for passing to headquarters of the N.F.U. National standardisation is, of course, desirable but conditions and costs are apt to vary in different parts of the country and so it is not so simple as might be thought.

* * *

Endeavours to reduce the smoke menace were made by the Glasgow City Council half a century ago. The *Electrical Review* of 26th November, 1909, reported that

> "a proposal has been adopted by which it is expected the comparative merits of gas and electricity as heating factors will be experimented with in various rooms of the municipal buildings . . . and the following proposal by ex-treasurer Stevenson has now been adopted by the Corporation: 'That with a view to the diminution of the smoke nuisance, it be remitted to a special committee to make arrangements for the holding of an exhibition for the purpose of showing the public the most up-to-date appliances for the utilisation of gas for lighting, heating and cooking purposes.'"

Somewhat ambiguously the resolution invited the Committee on Electricity to co-operate. Whether this meant helping to push the sale of gas appliances or co-operating by showing electrical appliances is uncertain.

Electricity and Amenities

TWO papers were presented to the Royal Society of Arts at a meeting in London on 25th November on the production and transmission of electrical power in the countryside, and the preservation of amenities. The first paper, prepared by Sir Christopher Hinton, chairman of the Central Electricity Generating Board, dealt with the increasing opposition raised to the Board's activities, particularly schemes for nuclear power plants and proposals for main transmission lines. Nuclear plants were opposed, he said, mainly because the present policy gave them a comparatively high degree of isolation. Although no health hazard existed with normal operation, there must be the possibility of a release of fission products should plant failure occur, resulting in a temporary evacuation of the surrounding area. Until more practical experience was available it was considered wise to place these stations in sparsely populated areas to limit possible inconvenience.

Power Station Sites

Even in the absence of a nuclear programme, however, the Board would be forced to propose the construction of conventional stations in similar situations to the present nuclear stations, as sites having the desired characteristics were uncommon, and it was now exceptional to find a suitable situation in an urban area. Because of the lack of sites, and the quantities of cooling water required, the rising power demands of the Greater London area could not be met indefinitely by building stations on the Thames Estuary. Although part of this load was being met by constructing stations on the River Trent, its cooling capacity was more limited than the Thames, while electrical transmission from the Midlands to the Home Counties was economically justified only if the lines were nearly fully loaded. The need to construct stations in the south-east on sites on the more open lengths of coast at present not subject to industrial development and regarded as amenity areas, would unquestionably arise within the next few years.

The problem of transmission lines was even more serious since they formed a countrywide network and were seen by more people. The advantage of a main transmission system was national rather than local, since the lines did not normally meet a local power demand, and it was natural that the opposition was primarily local. Opposition to nuclear power stations was more often from national bodies, as a station brought local benefits in rates, employment and trade.

The C.E.G.B. was charged by the 1957 Act with both supplying electricity and preserving amenities. It was an industrial body and must be financially successful, and although a financial yardstick could not be rigidly applied in assessing amenity values, some measurement should be made available to the Board, which was handling public money, before a decision was made. Of two similar sites being considered near London for a nuclear station, that having the greatest amenity value also offered a constructional cost advantage of £4 million and the possibility of its use could not therefore be dismissed. The cost per mile of a 275 kV double circuit overhead line was £25,000, compared with some £400,000 for underground cables of similar capacity, and there were many technical and engineering problems to be solved before this could be achieved in practice. Putting transmission underground would increase the Board's annual capital investment by about a half and, ultimately, the cost of electricity supplied to the Area Boards by some 20 per cent. Although the private consumer might be prepared to pay this extra to avoid the use of overhead lines, it would not be acceptable to the industrial user.

The cost of putting main transmission lines underground was prohibitive and, although short sections in special areas had been considered, technical difficulties were involved, with the increased possibility of failure; also, the terminal works at the change-over between the overhead and underground sections might be more objectionable than the continuous overhead line. Transmission lines operating at some 500 kV must be developed. These would have nearly four times the carrying capacity of the existing 275 kV lines, and the higher towers necessary would be compensated for by the reduced number of lines required.

Although present knowledge suggested that the correct sites for nuclear power stations were similar to that at Calder Hall, the development of A.G.R. type reactors using ceramic uranium and not metallic uranium as a fuel might permit relaxation of the siting conditions, but this would not remove the necessity to examine sites outside developed areas. The installation of more reactors on each site, and hence a reduction in the number of sites, would result in an increased labour force and its temporary accommodation, while if the generating capacity of the station considerably exceeded the power demands of the country within a reasonable distance the transmission line problem was worsened. The present practice, therefore, was to place nuclear power plants where facilities existed for expansion as the local load increased and where labour could conveniently be available.

Planning Problems

In the second paper, by Sir William Holford, Professor of Town Planning at University College, London, and a part-time member of the C.E.G.B., the scarcity of land and its proper use was considered. Since demand was known to be steadily increasing, the preparation of a 20-year plan by the C.E.G.B., listing a choice of suitable situations for power stations and lines and identifying areas from which they could permanently be excluded, might have been considered possible. Safety, economic and fuel policies, and technical development had reduced this period to five or seven years. In 1950 Hinkley Point would have been considered impracticable as a power station site since it lacked facilities for handling large quantities of coal, a requirement which had been abolished by nuclear power. No plan then could have foreseen this or the routes of the necessary transmission lines. New ground for industrial development was becoming more difficult to acquire, and sites were being increasingly reclaimed or redeveloped.

A great deal of imagination was being directed toward improving the comprehensive design of nuclear and conventional stations, though there was still more to be done, particularly with cooling towers, cladding materials and substations. The transmission line tower, even for 275 kV circuits when it was nearly 140ft high, was as simple and effective in design as it could be. The steel lattice had the least conspicuous outline when seen against sky or hill.

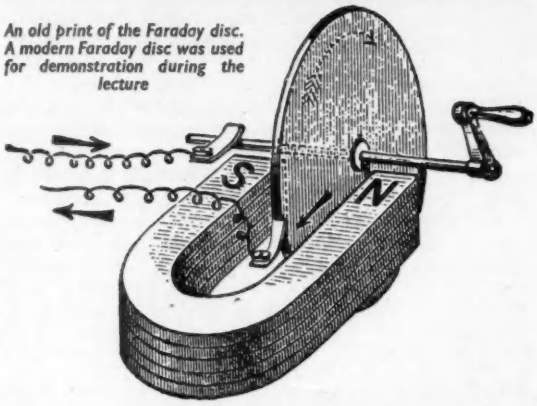
ELECTRICAL MACHINES

By
PROF. M. G. SAY
Ph.D., M.Sc., M.I.E.E.*

Summary by Prof. Say of the Faraday Lecture which was first delivered last Wednesday at Glasgow. It will be repeated in London on 17th February at the Central Hall, Westminster

A MACHINE converts energy from one form to another. An electrical machine may take in electrical energy and convert it to mechanical, or acoustic or some other form of energy: this is the action of a motor. But the action is reversible, for it may produce electrical energy from some other form: in this case, the machine acts as a generator.

The power available per head of the population is taken by some people as the standard of civilised life. The average workman in the United States has at his command,



An old print of the Faraday disc. A modern Faraday disc was used for demonstration during the lecture

with no more physical effort than it takes to move a switch, over one hundred times the energy that the Asian coolie has to produce in toil and sweat: and much of that power is from electrical machines. In civilised countries the dependence on machinery is very marked indeed, for machine-power is precise, dependable, tireless and cheap.

Electrostatic Machines

Known in simple forms for many years, electrostatic machines have become important to the nuclear physicist for producing voltages up to several million. One of these is the Van de Graaf machine, in which an insulating belt carries charges from a lower to an upper electrode as if on an escalator. The charges are collected at the top and the upper electrode gradually acquires a very high voltage. Mechanical work has to be done to move the belt, because every unit of charge taken up has to be raised against the repulsion force of all the charges that have been accumulated. So the Van de Graaf machine is a true electric generator.

Magnetic Machines

Nature has so arranged matters that usable electrostatic forces are very small and, in most electrical machines, a vital role is played by magnetism, with which the forces produced are very much greater. One of the commonest motors using magnetism is the simple relay. There are, quite literally, hundreds of millions of relays at work, switching telephones, controlling lifts, safeguarding electric supply systems.

More familiar, perhaps, is the rotating electromagnetic machine, particularly the motor. In the home, the housewife's sewing and washing machines, spin dryer, vacuum cleaner and food mixer, are all powered by little electric motors. A motor-driven alarm clock wakes the household. The husband shaves with an electric motor, and the hand-drill with its many useful gadgets helps his do-it-yourself activities. Motors drive trains, work lifts, operate office machines. They power tools in the factory, trucks for shifting materials, coal-cutters and mine-winders; they drive radar aerials, propel ships and work their stabilisers and have innumerable jobs to do in aircraft. Big generators are found in sizes up to half a million horsepower in power stations: small ones are found on every train and in every car.

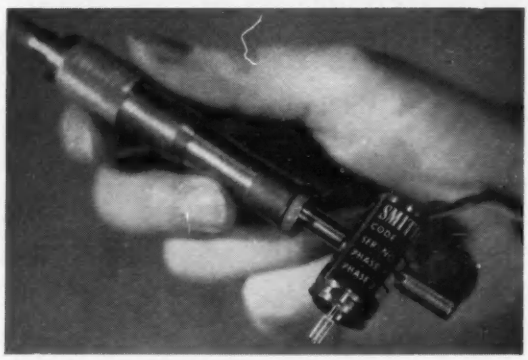
Rotary electrical machines can all work as motors or generators, for their action is reversible. The pumped-storage scheme, for example, uses an electrical machine as a motor to raise water from a low-level to a high-level reservoir; and when the water runs downhill again, the same machine unchanged becomes a generator.

Faraday's Discovery

These versatile, reversible electrical machines are the fruits of the genius of Michael Faraday. Faraday, son of a poor blacksmith, could not have had an education more than the most elementary. Apprenticed to a London bookseller at the age of thirteen, he read books as well as selling them and so made his first acquaintance with what must have been a complete new world of science. He eagerly attended scientific lectures. The now famous volume containing handwritten and beautifully-bound notes of four lectures on chemistry given by Sir Humphrey Davy, sent by Faraday at the age of twenty-one to Sir Humphrey asking to be allowed to become his laboratory assistant, did have the effect that young Michael so passionately desired.

By 1835, Faraday had succeeded his patron at the Royal Institution and his discoveries had made him famous. His

A miniature machine made by Smiths Aircraft Instruments, Ltd.



* Professor of Electrical Engineering, Heriot-Watt College, Edinburgh.

lectures on them were brilliant and his scientific advice was widely sought. He could have made an immense income, but he could not be tempted with money: so the most famous scientist of his age lived on little more than £200 a year and, refusing the takeover bids of commerce, devoted his life to wresting secrets from Nature.

Kindly, devoted, modest and honest, blessed with animal spirits yet deeply religious, few can match his epitaph. Fewer still have had such a profound influence on the years that have passed since, in the autumn of 1831, he brought to light the fundamental fact of the electrical machine.

His discovery was the principle of electromagnetic induction, first in the transformer, next in the rotating machine—that an electric current could be generated in a wire simply by moving it near a magnet. In ten epoch-making days, Faraday explored the new phenomenon so thoroughly that no one has been able to add anything to his work in the discovery of fundamental facts.

From 1831 onwards, it was simply a question of developing the idea. Faraday took no hand in this—he left it to the engineers. Asked about electricity, if it had any use, he would reply " What use is a baby? It will grow up!" By 1881, just 50 years after Faraday's monumental research, electricity had grown so much as a public service, that Parliament had to pass its first Electricity Bill.

How Machines Work

The principle of an electromagnetic motor is just this: a magnet will attract iron; it will attract or repel another magnet. If we can keep this action going, we have a motor. It needs a stator magnet and a rotor magnet. The trick is to magnetise the rotor so that it has a strong magnetism at right-angles to that of the stator: then there is a powerful torque turning it into alignment. The differences between motors—d.c., or induction, or synchronous—lies only in the kind of current each member of the machine has, and the arrangements necessary to maintain cross-magnetisation. In some of the machines, notably the induction types, we do not have to supply the rotor with current at all, for it has currents induced in accordance with Faraday's law.

Speed control is an interesting and important characteristic of a motor. The ease with which speed variation can be achieved depends on the kind of arrangement used to keep cross-magnetisation. Where wide speed range is needed, the d.c. machine is easily the best because its action is independent of speed. Public supplies are usually a.c., so that quite often conversion to d.c., either by machines or by rectifiers, is common if the cost justifies. Many very effective controls can be produced by this fruitful marriage of electromagnetics and electronics.

The most fascinating machines are the very large and the very small. The really big ones are found in large generating stations. They may weigh more than 200 tons, run at 3,000 r.p.m., and concentrate nearly 300,000 h.p. in one single machine. It is a real difficulty to get these monsters out of the manufacturers' works.

At the other end of the scale of size, we find the miniature machines, developed during the past two decades. Pieces of precision engineering, they may be no more than a half-inch in diameter and an inch long. These tiny machines are vital components in automatic controls. Not only can they relay indications of position, but they can control much more powerful machines to high degrees of precision.

The Future

The electrical machines have developed greatly in technique (but not in principle) since Faraday. They will develop a great deal further as new techniques and new materials appear. We may see small cores extruded, complete with slots, from ferrites, and stuck together with glue. Windings may be " printed " and the commutator may give place to the valve or the transistor. There is no doubt at all that machines will get smaller, lighter, cheaper and hotter: hotter, because new insulations will stand high temperatures without distress.

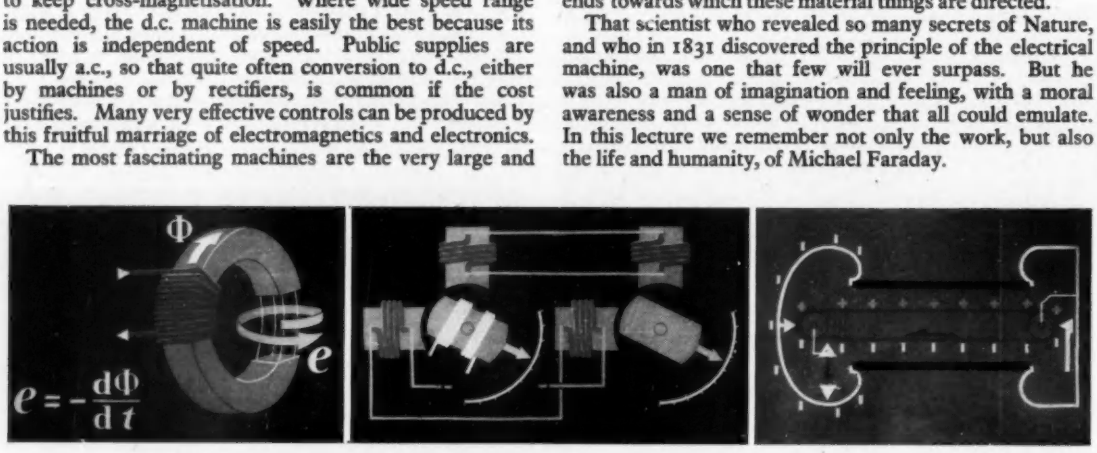
The future may not be unconnected with changes in human circumstances. What, for example, will happen when the oil is exhausted, and the internal combustion engine brought to a standstill ? Perhaps cars will be powered with electric motors energised from fuel cells.

The shape of machines may change. Already, flat and tubular (and even spherical) machines have made their appearance. The future of the machine seems assured. For, however we derive the energy of the future, it will almost certainly have to be distributed electrically and used electrically. The science that Faraday started shows no signs of finality.

The Problem

The electrical machine is one of the least deadly of all the inventions of man: but like them it presents a problem. The application of power—electric, or any other—is not merely the know-how of button-pushing; not only more automation, or going technically one better than the Joneses. It is deeply concerned with the ends towards which these material things are directed.

That scientist who revealed so many secrets of Nature, and who in 1831 discovered the principle of the electrical machine, was one that few will ever surpass. But he was also a man of imagination and feeling, with a moral awareness and a sense of wonder that all could emulate. In this lecture we remember not only the work, but also the life and humanity, of Michael Faraday.



Three of the diagrams which were shown n colour during the lecture in both still and cinema form. (a) Faraday's law; (b) Position indication; (c) Van de Graaf generator

H.M.S. 'HERMES'

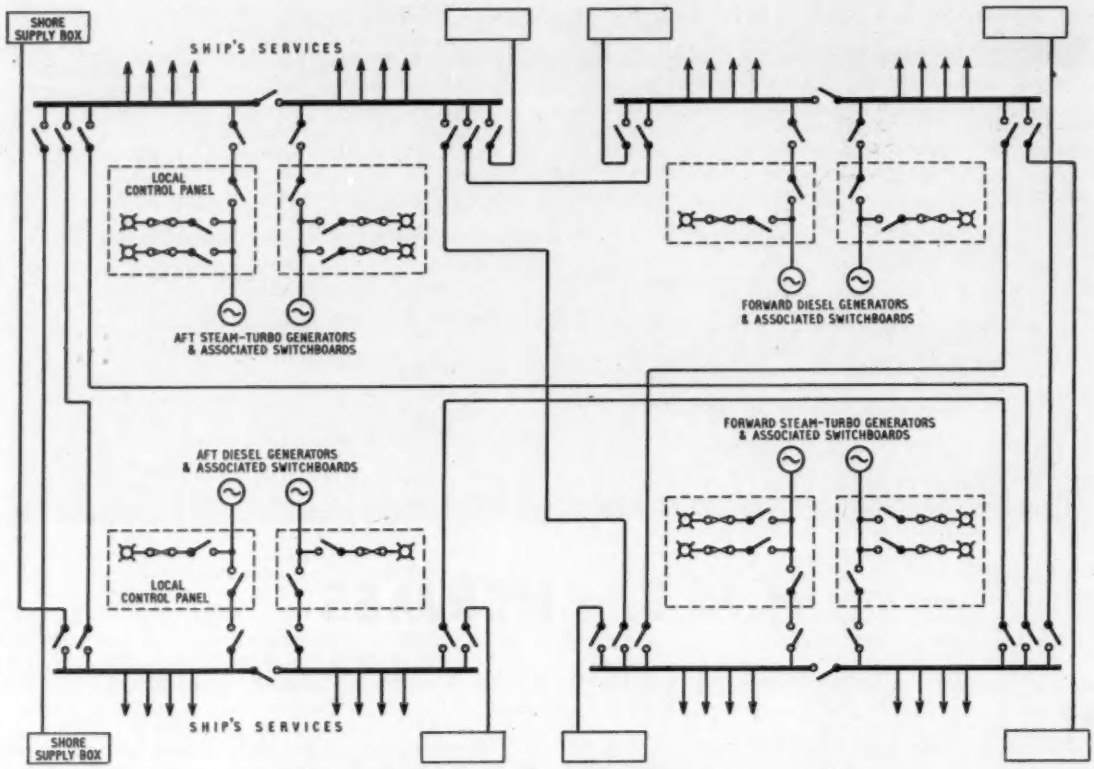
FIRST R.N. AIRCRAFT CARRIER WITH AN A.C. POWER SYSTEM

BRITAIN'S latest aircraft carrier, commissioned for trials and service with the Royal Navy on 25th November, is the 22,000 ton *Hermes* built at the Barrow-in-Furness works of Vickers-Armstrongs (Shipbuilders), Ltd. Although the vessel was originally laid down in 1944, work was delayed at the end of the war and the most recent aids to naval aviation have now been incorporated, including an angled flight deck, steam catapults, mirror landing aid and the latest radar system. Other modern features include an automatic boiler combustion control system and remote engine room controls operated from the ship's citadel, enabling the vessel to be steamed through radioactive fall-out. Last week we were privileged to visit the ship when the final acceptance trials were being carried out in the English Channel and saw some features of the first a.c. electrical power system to be installed in a British carrier.

The main generation and distribution is carried out by a 440 V, three-phase, 60 c/s, unearthed three-wire system. There is nearly 6 MW of installed capacity, including four 1,000 kW, 1,200 r.p.m., 0·8 power factor turbo-generators, situated two forward and two aft in separate compartments, supplied with steam from the main boilers. Each unit consists of a W. H. Allen turbine driving a B.T.H. alternator with an exciter on the same shaft and a belt-driven amplidyne pilot exciter. There is also a h.f. generator providing a 1,600 c/s supply to the automatic voltage regulator. In addition, there are four 360 kW generator sets, each comprising a Vickers-Armstrongs diesel engine and a B.T.H. generator and also situated two forward and two aft, for emergency use when steam is available or as the major power source when the boilers are shut down. Each of the eight generators has an associated local control panel and switchboard manufactured by Whipp & Bourne, Ltd., and from these switchboards the ship's services are supplied, either through solenoid-operated feeder breakers or, in the case of circuits having some form of protection such as motor starters with overload trips, through switch-fuse units.

An adequate reserve of generating capacity has been installed, and a number of interconnections are provided between the switchboards as indicated in the schematic diagram, to ensure supply continuity in the event of certain sections suffering action damage. Under normal sea-going conditions the load is supplied by one forward and one aft steam turbine set operating independently and with the switchboard interconnections made so that the boards associated with the diesel sets are energised from the steam set at the opposite end of the ship. With this arrangement a supply is still available for the major services, which have normal and alternative connections taken through automatic change-over switches from a "steam" and "diesel" switchboard at the same end of the vessel, if the normal supply board loses power. Pairs of generators associated with each switchboard are capable of continuous parallel operation if required, but the generators feeding different switchboards will not be run in parallel except during change-over periods.

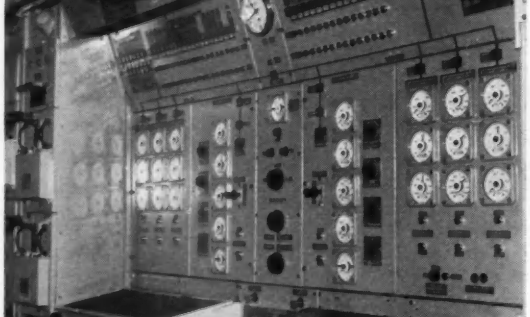
Each switchboard can be fed at up to 600 A from a shore supply through a connection box and breaker, and on each board output terminals are provided from which emergency supplies can be taken should the main distribution system be damaged. Throughout the ship are stored emergency use cables made to suit specified runs and having insulated plug-in connectors suitably coded to prevent incorrect phase connection. These cables are used in conjunction with connector boxes and risers to enable the temporary supplies to be taken through bulkheads and between decks without prejudicing the vessel's watertight integrity. Every distribution box has emergency use terminals and a change-over switch to isolate


SHORE SUPPLY BOX
SHIP'S SERVICES
LOCAL CONTROL PANEL
AFT STEAM-TURBO GENERATORS & ASSOCIATED SWITCHBOARDS
FORWARD DIESEL GENERATORS & ASSOCIATED SWITCHBOARDS
FORWARD STEAM-TURBO GENERATORS & ASSOCIATED SWITCHBOARDS
AFT DIESEL GENERATORS & ASSOCIATED SWITCHBOARDS
LOCAL CONTROL PANEL
SHIP'S SERVICES
SHORE SUPPLY BOX

Schematic arrangement of 440 V supply system

the permanent supply circuits, preventing power being fed back into the fault. Other equipment provided for use under abnormal conditions includes portable fuse-boards and lighting transformers for connection to the temporary cabling and portable electrically-driven pumps with their associated motor starters and leads which can be connected either to permanently wired positions or the emergency supplies.

The major machinery loads taken by the 440 V system include ventilation fans, hangar fire-fighting spray pumps, engine and boiler room auxiliaries and fans, the after and midships deck-edge aircraft lifts, winches, capstans, crane and steering motors, in addition to domestic machinery in the galleys, bakery and laundry. A large number of transformers up to 30 kVA capacity and incorporating Class "B" insulation have been supplied by Stewart Transformers, Ltd., giving 230 V for radio equipment and 115 V for "domestic" loads, including lighting; this is largely fluorescent with separate circuits in most compartments, each supplying half the fittings to reduce the risk of total lighting failure. Lighting for night flying indicates the outline of the flight deck, including the rundown at the stern, and shows the centre-line of the angled deck.



Switchboard for the two forward steam turbo-generator sets

Rotary convertor sets provide a 200 V, 400 c/s supply, largely for radio services, and 24 V d.c. for aircraft servicing, while a number of Westinghouse, Crypton and Electro-Dynamic Construction Co., Ltd., static transformer-rectifier units give 50 V d.c. for such general low-power services as the ship's three gyro-compasses and the 300-line automatic G.E.C. telephone exchange. In addition to this exchange, which also has a small manual board for use with G.P.O. extensions, there are 24 broadcast systems and a comprehensive sound-power telephone network.

The radio and radar system installed includes h.f., v.h.f. and u.h.f. communications radio, aircraft direction-finding equipment, carrier-controlled approach radar which enables aircraft to be "talked down" to the flight deck, and an air-direction radar with a large scanner similar in appearance to a searchlight mounted above the bridge. This gives three-dimensional—height, range and bearing—indication of aircraft positions at long ranges. Radar control is also provided for the ship's ten 40 mm anti-aircraft guns.

EARTH-LEAKAGE CIRCUIT-BREAKERS

Shock and Fire Protection for Domestic and Industrial Installations

By J. A. ROBBINS, B.Sc., M.I.E.E., A.M.I.Mech.E.*

A much higher degree of protection can be obtained with earth-leakage circuit-breakers than with fuses provided the device has been installed correctly. Examples of installation conditions which render the e.l.c.b. inoperative are given and remedies and testing procedures are discussed. The operation and reliability of the circuit-breaker itself are also described

WELL-DESIGNED voltage-operated earth-leakage circuit-breakers, properly constructed and correctly installed, give an extremely high degree of shock-risk and fire-risk protection to domestic and industrial installations. Yet, there is little official guidance on how they should be applied and even less on how the final installation should be tested. Furthermore, practical experience has proved that mere compliance with the requirements of B.S. 842 (voltage-operated e.l.c.b.'s) is not always enough to ensure satisfactory long-term operation. As a result it has been only too easy to blame the e.l.c.b. for failing to operate, when in actual fact the installation conditions have prevented it operating.

I.E.E. Regulations

The correct way to connect earth-leakage circuit-breakers is shown in Fig. 1. The first important point to note is that the e.l.c.b. electrode must be out of the effective resistance area of any other possible parallel earth paths on the installation. Secondly, the lead from terminal "E" to this electrode must be an insulated one. Both these fundamental requirements are laid down in I.E.E. Regulations and they are both intended to prevent one thing: complete or partial short-circuiting of the trip coil, thereby rendering the e.l.c.b. inoperative.

Faulty Installations

(*a*) *Short circuits.* Obviously, a chance connection between the protected metalwork and the circuit-breaker earth electrode (see Fig. 2) will short out the trip coil circuit and put the e.l.c.b. completely out of action. Alternatively, if the e.l.c.b. earth electrode is within the resistance area of any parallel earth electrode attached to the installation metalwork (see Figs. 3 and 4), the e.l.c.b. trip coil can only detect a portion, V_1, of the total potential difference, V, between this metalwork and earth. Consequently the level of protection afforded may be seriously affected.

The I.E.E. requirement of siting the e.l.c.b. earth electrode outside the effective resistance area of other earthed metalwork is not normally too difficult to meet in practice. From Fig. 4, it is clear that, with a 6ft rod electrode, 90 per cent of the total voltage to earth is dissipated in the first 8 to 10ft of soil immediately surrounding it. The actual tripping voltage limits specified in B.S. 842 are 24 V to earth, if the e.l.c.b. earth electrode has a resistance of 200 ohms; and 40 V if it has a resistance of 500 ohms. Then, if the e.l.c.b. earth electrode is so situated that only 80 per cent of the total voltage is detected, anything more than about 30 V

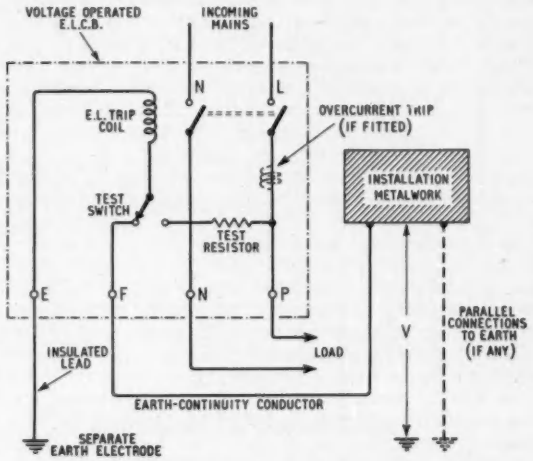


Fig. 1.—Voltage-operated earth-leakage circuit-breaker installation. Note insulated lead from E to separate earth electrode

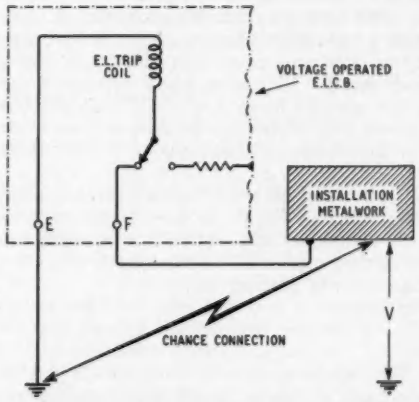


Fig. 2.—Trip coil shorted out by chance connection

* J. A. Crabtree & Co., Ltd.

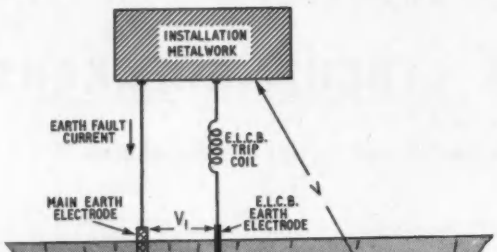


Fig. 3.—Effective resistance area of main earth electrode

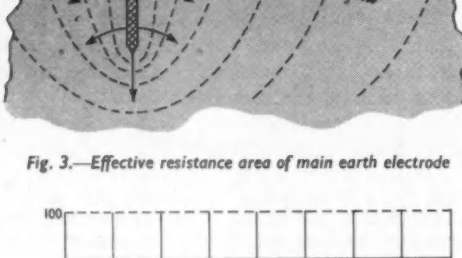


Fig. 4.—Voltage gradient in soil surrounding a 6ft long 1in diameter electrode

between installation metalwork and earth will still be detected, with an earth electrode resistance of 200 ohms. Even with a 500 ohm electrode, in practice an extremely high figure, anything more than about 50 V would be reliably detected. This value is still well within the 65 V safety limit adopted by most of the European countries. Furthermore, this calculation takes no account of the fact that most British e.l.c.b.'s are designed to work well within the 40 V, 500 ohm limit.

Thus, it is clear that an acceptable level of shock-risk protection will be afforded to the installation, providing the e.l.c.b. earth electrode is out of the immediate vicinity of other earthed metalwork: a distance of about 8 to 10ft should normally be perfectly adequate.

In the absence of a power supply to the installation, this requirement may be checked by carrying out two measurements of the installation earth electrode resistance. The first measurement, which should give the true earth electrode resistance of the main installation earth, is made in the normal way, the e.l.c.b. earth electrode being left unconnected. The resistance should then be measured a second time, using the e.l.c.b. electrode as the "potential" electrode (see Fig. 3). If the two resistance areas overlap, the second value obtained will be less than the true resistance. Providing the second value obtained exceeds about 85 per cent of the true resistance, the author would normally consider the spacing perfectly adequate.

When installing an e.l.c.b. earth electrode, care must be taken to avoid using any metalwork which may possibly become electrically linked to the installation metalwork in the future, as this would automatically short out the trip coil.

An example of this error, encountered only too often in practice, is the use of a water pipe as the e.l.c.b. electrode. It only needs the addition of an immersion heater to the installation to nullify the protective scheme completely. Yet, if a separate e.l.c.b. electrode, properly isolated from other metalwork, had been used in the first place, the immersion heater would simply provide a parallel connection between installation metalwork and earth and the level of shock-risk protection would remain virtually unaltered.

As may be seen by reference to Fig. 1, pressing the test switch disconnects the installation metalwork from the test circuit. In consequence, any installation condition resulting in a short circuit or partial short circuit of the trip coil will remain undetected, and the circuit-breaker may well be blamed for faulty operation when it is simply the method of installation which is at fault.

For this reason, it is desirable to apply a simple practical test to the installation to check that the entire protective system is working correctly. In the absence of any obvious low-resistance parallel earth paths, flashing from line to the installation metalwork through a suitable 100 W test lamp, under adequate safety precautions, provides an effective check on installation conditions. Where low-resistance parallel earth paths do exist, however, the net effect is to decrease the current sensitivity of the protective system, although the voltage sensitivity will remain unaltered. Consequently, a 100 W test load may not pass sufficient current to trip the circuit-breaker. In such circumstances, flashing from line to earth through a suitably protected 1 kW fire element provides a reasonable practical test of performance and has been used as such for a number of years now by a supply authority with a considerable experience of e.l.c.b. installations. Providing the unit operates correctly on such a test, it means that the maximum undetected earth current will not be in excess of about 4 A. In comparison, it must be realised that even a 5 A fuse will normally tolerate about 10 A for periods of the order of minutes.

(*b*) *Parallel earth paths.* The presence of parallel earth paths on the installation, providing the voltage-operated e.l.c.b. is correctly installed, does not affect the high degree of shock-risk protection afforded the user. Normally the only effect is to decrease the current sensitivity of the protective system, although even then it usually compares very favourably with even 5 A fusing. Unfortunately, however, there is one factor in the distribution network system over which the contractor has no control: a factor which can effectively prevent the e.l.c.b. detecting an earth fault under low-resistance parallel earth path conditions.

This particular factor is the impedance of the supply authority's neutral earth electrode. If an earth fault occurs on the installation with direct earthing, the line-to-neutral voltage normally divides up into the voltage across the fault, V , the voltage between installation metalwork and earth, V_e, and, finally, the voltage between

neutral and earth (V_n) (see Fig. 5). Thus, the neutral will become live, i.e. a degree of neutral inversion will appear, both line and neutral now being live to "true" neutral. What is more, the ratio of V_n to V_e will be proportional to the ratio of the supply authority's neutral earth electrode impedance to that of the consumer's installation earth electrode impedance, the actual values of V_n and V_e being dependent on the value of the fault resistance. Under direct earth fault conditions V_n and V_e will together add up to full mains voltage.

The importance of this point, in relation to the correct operation of a voltage-operated e.l.c.b. protective system, is that the e.l.c.b. is influenced only by the actual value of V_e: it trips out when this voltage exceeds the predetermined danger levels set down in B.S. 842. If parallel earth paths exist at the consumer's end, however, the consumer's installation earth electrode resistance may be low. In consequence, if the neutral earth electrode resistance—over which the contractor has no control—is relatively high, this ratio of V_n to V_e may be so large as to prevent the actual value of V_e ever rising high enough to trip the e.l.c.b. In other words, the bulk of the available mains voltage, even under direct earth fault conditions, will appear between neutral and true earth, the voltage on the consumer's installation metalwork remaining below the normal e.l.c.b. operating voltage level.

Conditions such as these, where an undetected earth fault on an e.l.c.b. installation produced dangerous neutral inversion, resulted in an electrical fatality only a few years ago. Once again it is not the e.l.c.b. which is at fault. There is no shock risk, as far as the installation metalwork at the consumer's end is concerned, as the voltage on the metalwork would be below the accepted safe limits. The real trouble is, of course, the relatively high neutral earth electrode impedance and the correct course of action is for the supply authority to reduce this impedance.

One course of action the contractor may take is artificially to increase the impedance of the consumer's parallel earth path. The low impedance is almost invariably due to a connection to a metallic water mains system, and a few feet of non-metallic piping strategically placed at the point where the water main enters the premises will usually improve the position.

For these few installations—where neither flashing to earth through a 1 kW fire element nor, in some instances, applying a direct earth fault, will trip out the e.l.c.b.—a convenient alternative solution is really required. For such installations, the author has suggested that the

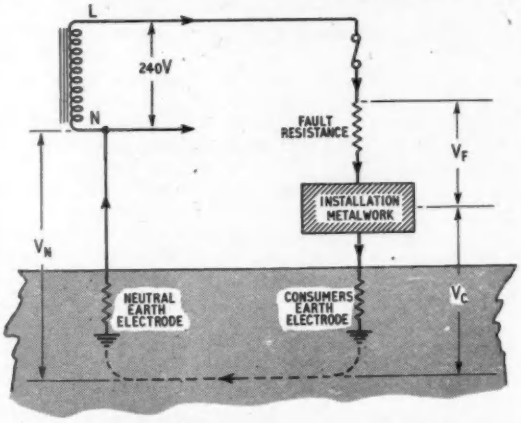


Fig. 5.—Voltage distribution on occurrence of earth fault

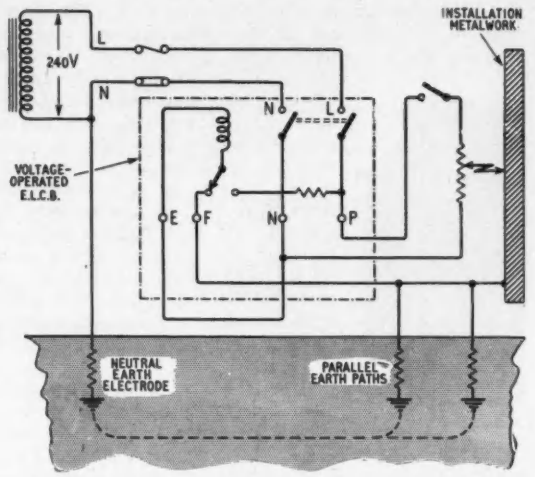


Fig. 6.—Suggested method of connection for relatively low-resistance parallel earth path conditions; e.l.c.b. earthed to neutral

circuit modification shown in Fig. 6 should give excellent earth fault protection. By "earthing" the e.l.c.b. to the neutral conductor instead of to an earth electrode, the trip coil will now measure the vector sum of V_e and V_n. The danger of neutral inversion will be eliminated and the degree of fire-risk protection very greatly improved. This solution also applies where it is impossible to place the earth electrode outside the effective resistance area of the main earth electrode.

However, this suggested method of connection constitutes a form of protective multiple earthing and hence would presumably need official sanction before it could be adopted in this country, even on a trial basis. The system has none of the disadvantages normally associated with conventional p.m.e. systems. It does not fail to danger if neutral breaks or becomes discontinuous. On the contrary, a faulty neutral would be detected immediately a load was switched on. Furthermore, unlike p.m.e., this system could readily be applied to individual installations: it need not be restricted to cases where it must be applied to the entire distribution network. When really difficult earthing conditions are encountered, there seems to be no need to bring the neutral earth electrode resistance down to the p.m.e. limit of 10 ohms.

As a matter of interest, this method of connection has now been used for some time for these special installation conditions with complete satisfaction. The supply authority in question operates in a very rural area and hence is in a position to speak with some authority on earth leakage problems.

Mechanical Reliability

Among further difficulties which may be encountered is that of failure of the mechanism. Unfortunately, earlier designs of e.l.c.b.'s, with the design accent on a high degree of sensitivity and with flimsy and poorly protected mechanisms, tended to give an impression of mechanical unreliability. The present trend is towards sealed, virtually dustproof, enclosures for the mechanism. Furthermore, a more realistic appraisal of the degree of sensitivity required, unclouded by the old meaningless 30 mA tripping-current requirement, together with more robust and considerably more reliable mechanisms, all combine to reduce the possibility of mechanical trouble to the absolute minimum.

(*a*) *Broken connections.* The test switch not only tests

the mechanism but also checks the continuity of the earth lead, the effectiveness of the earth electrode and the overall voltage sensitivity of the protective system. One major advantage of e.l.c.b. earth-leakage protection is that the e.l.c.b. earth electrode resistance need not be particularly low but—like all other methods of earth-leakage protection—the system is still completely inoperative if the earth lead is severed. It is important to note, however, that with e.l.c.b.'s such a failure may readily be detected by means of the test switch: with other methods such a failure is usually detected only by an unfortunate accident.

Fig. 7.—Voltage-operated earth-leakage circuit-breaker. Note separate covers for terminal chamber and sealed enclosure for mechanism

Even the test switch, however, cannot detect a broken earth continuity conductor. Hence, although I.E.E. Regulations call only for the lead to the e.l.c.b. earth electrode to be insulated, using an insulated earth continuity conductor has some advantages. The insulation provides additional mechanical protection for the lead and an insulated lead is normally treated with far more respect than a bare lead—the average handyman is not quite so liable to sever it or otherwise maltreat it.

(*b*) *Trip coil.* The risk of the trip coil burning out can be assessed by considering the maximum voltage that may be applied to the coil and the maximum voltage the coil may have to sustain indefinitely. The maximum voltage that may be applied to the coil is full mains voltage to earth, i.e. up to 250 V. At this voltage, a correctly designed and constructed B.S. 842 e.l.c.b. should trip in less than 0·1 sec—the actual total operating time will probably be less than 1 cycle (0·02 sec). During this brief space of time, the impedance of the trip coil itself will limit the actual current flowing through the coil to less than 1 A. The normal coil, wound with at least 38 s.w.g. wire, will easily sustain this current, at least for a matter of some seconds, which is far in excess of the maximum tripping time mentioned above.

The other factor to be considered is the maximum no-trip current. To comply with implicit B.S. 842 requirements, this, in practice, cannot exceed about 70 mA—a current well within the continuous rating of even a 38 s.w.g. coil. In the e.l.c.b. illustrated in Fig. 7, the no-trip current flowing continuously will produce a temperature rise of less than 10°C.

There is therefore no risk of the trip coil failing, under correct operating conditions, due to electrical overloading. Indeed, as will be seen later, the major factor influencing e.l.c.b. trip coil design is the mechanical strength of the winding, not the electrical performance. Yet there are some burn-outs or apparent burn-outs of trip coils and, rightly or wrongly, the natural tendency is to blame the e.l.c.b. These may normally be divided into two main classes: the apparent burn-outs, due to lightning troubles, and the real burn-outs, which are almost invariably due to incorrect installation conditions, not faulty e.l.c.b. trip coils.

The first possibility, that of lightning damage, is something to which older types of e.l.c.b. were particularly prone. Whilst lightning damage may appear rather similar to a burn-out, a coil damaged by lightning will normally show unmistakable symptoms. There is nearly always gross mechanical damage to the coil: the windings appear to have burst open; the burning, if any, is normally restricted to the outer layer of conductors; quite often the end cheeks are blown off the coil bobbin.

Whilst there is obviously very little that can be done to protect an installation against damage from a direct lightning strike, correct design can virtually eliminate the possibility of damage to e.l.c.b. trip coils due to nearby lightning disturbances. The first essential is a scientifically-designed spark gap to protect the coil. This gap should preferably be a radial one, as shown in Fig. 8, from considerations both of speed of breakdown and also of consistency in operation. Since the spark gap must be connected directly across the coil terminals to be most effective, it is obviously essential to ensure that the gap cannot readily be shorted out. It should, therefore, be situated in a position where it is protected against accidental bridging and the creepage path should be very long compared with the clearance across the gap.

A spark gap alone, however, is not sufficient to ensure complete protection for the trip coil. An essential design feature is a strong coil bobbin, with the end cheeks either well supported or made of an inherently tough material,

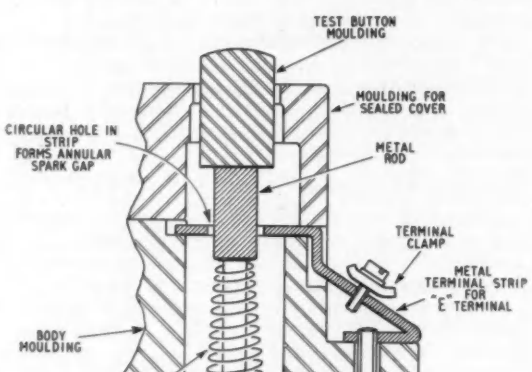

TEST BUTTON MOULDING
MOULDING FOR SEALED COVER
CIRCULAR HOLE IN STRIP FORMS ANNULAR SPARK GAP
METAL ROD
TERMINAL CLAMP
METAL TERMINAL STRIP FOR "E" TERMINAL
BODY MOULDING
RESET SPRING FOR TEST SWITCH

Fig. 8.—Annular spark gap. Note long creepage distance and use of clamp type terminal to avoid damage to vital earth lead

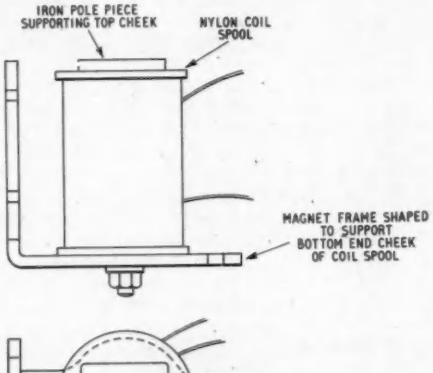


Fig. 9.—E.l.c.b. trip coil specially designed to withstand lightning surges

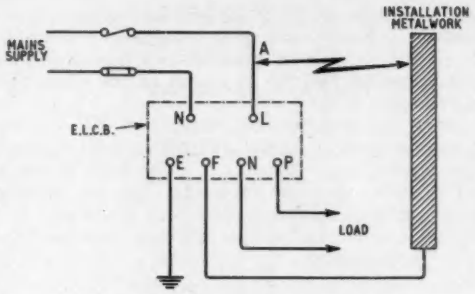


Fig. 10.—Earth fault on live side of e.l.c.b.

such as nylon (see Fig. 9). The winding itself, and in particular the end windings of the coil, must be mechanically strong. Finally, a spark gap, correctly designed and positioned, completes the protection. It has been proved in practice that a circuit-breaker incorporating all these features is virtually immune from lightning damage.

As yet, there is no test laid down in B.S. 842 to check the degree of protection afforded to the trip coil against lightning damage. There is, however, a test at present under consideration for incorporation in the Continental draft specification for voltage-operated e.l.c.b.'s.

Fig. 11.—Earth-leakage circuit-breaker enclosed in an insulated metal case

As we have seen earlier, the possibility of the trip coil burning out under normal conditions of operation is so small that it may be ignored. Unfortunately, however, there are some incorrect installation conditions which may result in a coil burn-out. Basically, they all reduce down to an earth fault to the metalwork protected by the e.l.c.b. from a source of supply not controlled by the e.l.c.b. Fig. 10 illustrates a typical example of this. Under poor earthing conditions, such as are usually associated with e.l.c.b. installations, a fault at point A would be most unlikely to blow the main fuse. This fault on the live side of the e.l.c.b., to the installation metalwork, results in full mains voltage being applied to the trip coil. The earth fault current thus continues to flow even though the e.l.c.b. operates: inevitably under these conditions the trip coil must burn out.

This basic condition may arise in several ways. In one instance, the supply authority's service conductor had developed a fault to the installation metalwork near the supply intake position, resulting in a burnt-out e.l.c.b. trip coil. A second possibility of trouble arises when common metalwork links several premises—a metallic water pipe being a typical example. Here, an earth fault on one installation can travel along the water pipe, resulting in burnt-out trip coils in e.l.c.b.'s protecting the other premises, unless all the installations are protected by e.l.c.b.'s.

This condition, i.e. an earth fault on the incoming mains side of the protective gear to installation metalwork, is always liable to occur when metalclad switchgear is used. When earthing conditions are excellent, the main back-up fuse should blow. If earthing conditions are not quite so good, however, whether direct earthing or e.l.c.b. protection is being used, it is no longer safe to assume that the back-up protection will operate. For this reason B.S. 842 stipulates all-insulated enclosures for voltage-operated e.l.c.b.'s.

Sometimes, however, to suit special installation conditions it is necessary to mount the e.l.c.b. unit in either a sheet metal case or, possibly, a weatherproof/dustproof enclosure. In such circumstances, special precautions should be taken to guard against the risk of an earth fault to the metal case occurring on the live side of the circuit-breaker. To insure against this hazard the weatherproof housing illustrated in Fig. 11 is provided with a special insulating lining, and care has been taken to ensure that no metallic screws, etc., protrude through this protective lining into the interior of the enclosure. Finally, for complete protection the incoming mains supply should be taken into the metallic enclosure through an insulating bush or a length of non-metallic conduit.

Another Method of Protection

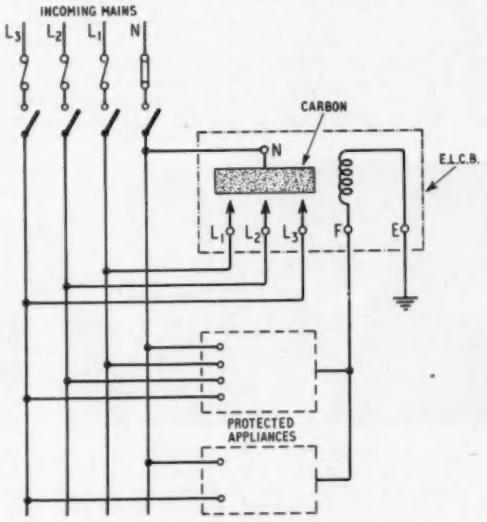
An interesting alternative method of earth-leakage protection is illustrated in Fig. 12. This Danish type of e.l.c.b. is quite capable of dealing with faults on the incoming feeder as well as on the load side: hence metallic enclosures would no longer present any problem. Whilst the unit bears a basic family resemblance to a B.S. 842 e.l.c.b., in that all the protected metalwork is connected to earth through the trip coil of the circuit-breaker, the method of operation is slightly different.

When an earth fault occurs, instead of this unit isolating the circuit itself, it forces a piece of carbon—which is connected to neutral—across three contacts which are connected to each of the three incoming phases. The resultant interphase fault should then blow all the back-up fuses. Naturally, no test switch is fitted, as replacing blown fuses each time the test switch is pressed could be an expensive hobby!

Conclusions

The I.E.E. Regulations specify that certain basic conditions regarding earth-fault-loop impedances shall be met, if direct earthing is to be relied upon for earth-leakage protection of an electrical installation. Even then complete shock-risk protection is not necessarily

Fig. 12.—Schematic diagram of a Danish type of e.l.c.b.



provided to the installation. For complete protection against a possible shock at full mains voltage, circuit isolation should certainly be achieved in less than 0·1 sec. This is to take care of the possibility of an earth fault occurring whilst someone is in contact with the installation metalwork or the appliance.

If the actual fault current is only about three times the fuse rating, i.e. the I.E.E. limit, the fuse can easily take a matter of ten seconds or so to blow—a time delay which may well have lethal consequences. As an immediate comparison, B.S. 842 specifies a maximum operating time of 0·1 sec, with only 30 V to earth.

When "voltage-operated" protection is being used, I.E.E. Regulations again stipulate certain basic requirements, namely, a separate earth electrode and an insulated lead between the e.l.c.b. and this electrode. With both direct earthing and e.l.c.b. protection, however, it is also necessary to comply with good installation practice, i.e. to ensure that there is no possibility of installation metalwork becoming live due to a fault on the mains side of the protective device.

Complying with the requirements of B.S. 842 is not enough in itself to ensure reliable long-term operation from a voltage-operated e.l.c.b. The basic design must also provide adequate protection for the mechanism against arduous operating conditions and adequate protection for the trip coil against lightning disturbances.

An earth-leakage circuit-breaker embodying these design features—correctly installed and regularly checked by means of the test switch—should give an extremely high degree of shock-risk and fire-risk protection to a normal electrical installation.

EAST MIDLANDS CENTRE DINNER

ABOUT 180 members and guests attended the annual dinner of the East Midlands Centre of the Institution of Electrical Engineers held at Nottingham on 18th November. The vice-chairman of the Centre, Lt.-Col. W. E. Gill, T.D., M.I.E.E. (telephone manager, Peterborough), proposed "The City of Nottingham," to which the Lord Mayor, Councillor John Kenyon, J.P., responded. His remark that his wife had recently changed her gas cooker for an electric cooker was met with loud applause. He went on to say that, as chairman of the City Education Committee, he was interested in the Institution's work in encouraging research.

Replying to the toast of the Institution of Electrical Engineers proposed by Mr. J. N. Frears, C.B.E., M.A., J.P. (managing director, Frears & Blacks), Mr. G. S. C. Lucas, O.B.E., M.I.E.E. (vice-president, I.E.E.), remarked upon the strength of the Centre which, although it had only been in existence as such for 13 years, already had two Sub-Centres. Referring to the rate of expansion of the industry, he said that the number of people employed had been doubling every 14 to 18 years and the membership of the Institution had followed suit. They needed to look very carefully to the use they made of their professional manpower; he felt sure that many jobs were still being done by professional engineers which technicians trained for the job could do. There were five technicians for every professional man and it was a matter of some urgency that these technicians should be established in their own right and with their own technical qualifications. Mr. Lucas then referred to the recent unusual activity at the Institution which led to two special general meetings. The Special Committee promised by Mr. S. E. Goodall had started work and was now considering the hundreds of letters that had been received. "There is no doubt that the Council has had a good shake-up," he said, but this was to the good if they could sift out the constructive suggestions and use them to the benefit of members.

The chairman of the Centre, Mr. D. H. Parry, B.Sc., M.I.E.E. (manager, Leicester Sub-Area, East Midlands Electricity Board), proposed the toast to the guests. In the absence of Mr. J. A. MacKerrell due to illness, Mr. C. R. King, C.B.E. (chairman, Electricity Council), responded. Finally, Mr. D. E. Lambert, B.Sc.(Eng.), M.I.E.E., immediate past-chairman, proposed the health of the present chairman.

I.E.E. Special Committee

THE constitution of the Special Advisory Committee of the Council is given in the November issue of the *Journal* of the Institution of Electrical Engineers. This Committee was proposed by the President at the special general meeting held on 18th August. Having supported the proposal, the Council decided that the Committee should consist of 14 members, seven chosen from the present Council and seven non-members of the Council. It will report to the Council on all comments and proposals received from members, at meetings and in correspondence, on the activities and organisation of the Institution and, where appropriate, will recommend suitable action. The Committee will also make recommendations to the Council on the ways and means of improving channels of communication between the Council and the members to secure a better appreciation of the Council's activities and responsibilities. The Committee has already started work.

Left: The Lord Mayor of Nottingham (Councillor J. Kenyon, J.P.) replying to the toast of the City of Nottingham. Centre: Mr. D. H. Parry (chairman of the Centre), Councillor J. Kenyon and Lt.-Col. W. E. Gill (vice-chairman). Right: Mr. J. N. Frears, C.B.E., J.P. (managing director, Frears & Blacks), Mr. D. E. Lambert (immediate past chairman, East Midlands Centre) and Lt.-Col. G. H. Vere-Laurie, J.P. (Deputy Lieutenant of the County of Nottingham and chairman of the Governors of Newark Technical College)

OVERSEAS ELECTRICAL TRADE

UPWARD TREND OF EXPORTS STRENGTHENED IN OCTOBER

THE value of electrical goods exported in October rose sharply to £20·4 million compared with an average of £17 million in the previous two months. The total for the period January to October was £191 million, or £8 million more than in the corresponding period of 1958. Because of the inevitable monthly fluctuations, a better guide to the continuing upward trend of exports is to take the months of September and October together. On this basis electrical exports were 14 per cent higher this year than in September and October, 1958. In the eight months January to August they had been only 3 per cent more than a year earlier.

The increase in exports this year is still largely accounted for by radio and other electronic equipment and valves and cathode-ray tubes, the total value of which was 22 per cent above the 1958 level. Shipments to Western Germany of these products this year (£2·4 million) were over twice the value achieved in the first ten months of 1958. India (£2·1 million) took nearly twice as much, the United States (£2·2 million)

TABLE I.—ELECTRICAL EXPORTS

Class	Month of October, 1959	Ten months ended 31st October, 1958	Ten months ended 31st October, 1959
	£	£	£
Generating sets and generators:			
Diesel-driven, up to 10 kW	122,640	1,154,486	1,096,020
Ditto, 10 to 65 kW	131,939	1,958,949	1,353,740
Ditto, 65 to 200 kW	153,389	1,877,007	1,597,958
Ditto, over 200 kW	190,511	3,996,094	2,687,398
Spark ignition engine driven	8,603	152,398	113,037
Steam turbine driven	5,041	684,437	657,826
Hydraulic turbine driven	—	17,542	—
Other prime mover driven	96,739	168,608	257,043
Generators, not exceeding 200 kW	135,271	1,242,782	1,015,041
Ditto, over 200 kW	63,206	923,874	830,837
Parts of generators	729,530	6,961,684	6,627,183
Motors, complete, other than railway, tramway and trolley-bus:			
Up to ½ h.p.	257,968	1,535,742	1,699,878
Over ½ but under 1 h.p.	61,046	478,576	473,766
1 h.p. to 250 h.p.	516,025	4,455,745	4,236,673
Over 250 h.p.	175,089	1,238,776	1,995,299
Railway, tramway and trolley-bus motors complete and parts of all motors	193,208	2,111,709	2,476,589
Motor starting and controlling gear	211,646	2,574,771	3,182,811
	3,051,849	31,533,180	30,301,099
Converting machinery	41,675	290,857	491,748
Mercury-arc rectifiers	91,072	1,050,916	707,845
Transformers for lighting, heating and power (incl. coils):			
Not exceeding 7,500 kVA	665,947	5,907,998	4,813,164
Over 7,500 kVA	1,093,622	4,352,957	4,740,537
Switchgear and switchboards (not telegraph or telephone), up to 200 A and 660 V	346,371	4,029,340	3,555,850
Ditto, other	1,205,682	9,990,697	11,848,145
	3,444,369	25,622,765	26,157,289
Primary batteries:			
Lighting	96,691	900,026	976,244
Radio	420,074	2,973,642	3,460,785
Other	33,641	445,070	357,222
Parts (excl. carbons)	57,925	469,367	481,169
Lamps:			
Filament, exceeding 28 V	113,172	812,851	898,419
Ditto, under 28 V	31,840	300,582	276,594
Arc lamps and searchlights	9,147	185,736	159,292
Discharge lamps, fluorescent tubes, etc.	92,818	867,095	893,963
Radio and television, etc., apparatus:			
Thyratrons, hot cathode mercury vapour and gas-filled rectifiers (excl. mercury-arc rectifiers), photo-electric cells, stabilising and cold cathode valves, magnetrons, klystrons	44,921	262,178	428,305
All other*	456,196	4,156,939	4,873,974
Parts (excluding glass bulbs)	39,881	211,149	308,557
Radio and television transmitters	61,696	349,671	912,699
Commercial radio and radar equipment	1,747,397	11,865,031	15,586,386
Domestic radio receivers, mains	82,038	834,922	854,147
Ditto, battery	73,299	513,515	579,166
Ditto, other (incl. car)	36,097	227,155	305,000
Radiograms	33,709	328,150	246,554
Television sets	73,264	799,272	628,765
Public address equipment	117,217	898,112	933,155
Other radio and television apparatus, n.e.s.	84,565	346,516	687,788
Components and parts, n.e.s.	996,675	7,362,375	8,139,588
	3,846,954	28,154,985	34,484,084
Telegraph and telephone installations	623,246	7,361,824	7,067,877
Telephone instruments, separately consigned	77,385	1,563,108	993,236
Telegraph and telephone parts	700,171	7,696,189	7,642,491
Line apparatus for long distance communication	180,599	1,701,482	2,433,793
	1,581,401	18,322,603	18,137,397

Class	Month of October, 1959	Ten months ended 31st October, 1958	Ten months ended 31st October, 1959
	£	£	£
Cookers	51,766	547,527	385,346
Toasters	23,668	237,017	176,711
Other cooking apparatus	53,655	316,188	387,840
Parts and accessories	97,018	635,974	869,218
Space heating appliances	36,762	314,477	245,916
Water heating appliances	27,522	255,863	286,464
Other heating appliances	57,641	286,382	276,321
Parts and accessories	103,841	691,459	804,326
Irons	91,011	737,595	711,367
Arc welding equipment, a.c.	22,479	460,557	348,656
Ditto, d.c.	27,774	749,059	474,699
Resistance welding equipment	25,890	141,165	337,625
Electric furnace plant	105,212	989,647	864,455
Magnetos, ignition	8,678	146,242	123,509
Sparking plugs	206,301	1,494,212	1,646,035
Elec. appliances for aeroplanes, n.e.s.	329,190	2,828,595	3,306,563
Ditto, for motor vehicles, n.e.s.	512,152	3,836,632	4,011,923
Ditto, for cycles, n.e.s.	46,605	532,726	396,765
Signalling app. (incl. traffic signals)	130,991	1,420,793	2,070,870
Instruments, commercial	165,661	1,725,259	1,703,146
House service meters (including parts)	133,692	1,464,733	1,353,411
Electro-medical apparatus (not X-ray)	44,125	520,066	321,779
X-ray apparatus (excl. tubes and valves)	69,152	546,618	521,250
Ceiling fans, complete	49,427	1,035,502	808,856
Desk fans, complete and parts of desk and ceiling fans	27,935	320,872	221,425
Vacuum cleaners	140,670	1,217,698	1,372,302
Floor polishers	58,107	686,046	697,092
Food mixers	81,365	559,596	671,472
Hair clippers and dry shavers	100,970	550,576	542,037
Other portable appliances	32,749	169,671	226,892
Parts	190,075	1,063,100	1,307,719
Portable elec. tools (not saws) and parts	266,229	2,060,553	2,078,891
Cables and wires:			
Telegraph and telephone, submarine	44,982	679,171	4,056,273
Ditto, other	291,827	5,151,797	3,703,514
Cotton, silk or art. silk insulated	19,225	423,604	188,102
Enamel, glass or asbestos insulated	118,958	1,045,161	902,686
Paper insulated	417,166	6,406,744	5,368,389
Rubber insulated	286,389	4,353,471	2,824,558
Thermoplastic insulated	258,899	1,896,061	2,578,012
Other	205,676	2,199,140	1,612,344
	1,643,122	22,155,149	21,233,878
Accumulators for motor vehicles	127,319	1,501,561	1,409,515
Ditto, traction	11,651	199,610	193,239
Ditto, radio and other portable	44,164	575,834	315,242
Ditto, other	64,635	318,209	520,360
Parts and accessories	85,358	917,534	818,122
Electric wiring accessories	221,097	1,730,231	2,031,243
Elec. ceramic ware, etc. (incl. insulators), n.e.s.	87,203	1,035,198	988,268
Insulating cloth and tape	56,885	490,086	538,874
Other insulating material	152,859	974,211	1,377,168
Permanent magnets	58,983	471,302	461,182
Radio, telegraph and telephone testing equip., n.e.s.	153,975	712,519	1,260,284
Scientific elec. instruments (excl. telegraphic or telephonic, time recorders and time switches)	308,118	3,546,473	3,496,965
Electrical machinery, n.e.s.	159,840	805,669	414,603
Electrical apparatus and appliances, n.e.s.	1,120,962	8,419,343	9,835,869
TOTAL	20,394,365	182,983,251	191,029,250

* The figures for 1959 are not strictly comparable with those for 1958.

TABLE 2.—DISTRIBUTION OF EXPORTS (TABLE 1)

Country	Month of October, 1959	Ten months ended 31st October, 1958	Ten months ended 31st October, 1959
	£	£	£
Gibraltar	6,275	280,202	95,800
Malta and Gozo	99,718	589,517	452,017
Cyprus	68,805	704,844	571,473
Sierra Leone	54,324	550,184	366,126
Ghana	293,651	1,512,099	2,339,632
Nigeria	520,558	3,684,186	4,668,691
Union of South Africa	1,392,826	15,811,076	15,621,710
Rhodesia and Nyasaland	549,429	4,386,600	6,208,488
Tanganyika	48,778	461,242	425,313
Kenya	159,314	1,317,217	1,727,354
Uganda	34,896	545,537	435,177
Mauritius	79,517	378,972	501,024
Aden	43,836	547,451	492,305
Bahrain, Qatar and Trucial States	138,607	888,425	1,058,664
Kuwait	200,285	1,663,479	1,926,361
India	2,083,719	15,272,380	17,108,756
Pakistan	212,342	2,159,543	2,338,148
Singapore	224,437	3,160,564	2,444,167
Federation of Malaya	206,022	2,906,867	2,224,423
Ceylon	186,426	1,529,289	1,891,615
British North Borneo	121,389	196,558	407,328
Sarawak	12,969	230,941	137,746
Hong Kong	463,966	2,948,687	4,077,926
Australia	2,694,774	15,767,409	15,990,511
New Zealand	831,190	11,162,840	7,548,839
Fiji	19,280	286,635	272,791
Canada	1,052,084	11,691,971	10,760,355
Jamaica	145,362	1,380,454	1,431,779
Barbados	33,024	252,037	314,002
Trinidad	126,736	1,179,478	1,230,614
British Guiana	31,081	698,574	614,112
Other Commonwealth countries	143,761	1,602,416	2,046,523
Irish Republic	413,499	2,852,150	3,086,109
Soviet Union	152,482	504,497	1,086,444
Finland	139,723	1,123,966	1,045,097
Sweden	439,317	4,452,847	4,512,026
Norway	222,006	2,021,883	2,070,897
Denmark	280,842	1,844,007	2,291,414
Poland	92,751	653,369	663,228
Western Germany	493,304	2,875,546	5,103,947
Netherlands	563,299	6,139,705	6,195,807
Belgium	290,693	2,795,252	2,933,530
France	351,430	3,256,267	2,616,111
Switzerland	183,577	1,629,407	1,693,942
Portugal	132,263	2,742,402	1,941,000
Spain	92,447	1,683,804	1,662,157
Italy	344,590	2,699,106	3,072,177
Austria	39,278	458,236	439,308
Yugoslavia	100,041	624,007	711,794
Greece	68,433	805,282	1,099,166
Turkey	51,462	992,849	583,208
Belgian Congo	94,046	352,530	545,747
Portuguese East Africa	40,544	221,343	259,525
Egypt	43,355	931,781	1,455,796
Libya	59,031	580,800	688,358
Morocco (excluding Tangier)	13,520	396,397	290,281
Sudan	99,967	892,563	860,749
Syria	12,896	285,051	226,234
Lebanon	59,412	440,413	516,742
Israel	57,336	1,025,837	1,005,158
Jordan	50,462	745,563	734,760
Saudi Arabia	43,705	729,082	538,770
Iraq	169,109	2,675,732	2,658,791
Iran	292,586	3,362,862	2,811,471
Burma	180,655	761,261	1,060,529
Thailand	47,510	1,126,444	818,677
Indonesia	66,248	284,398	403,369
Japan	51,624	426,269	680,949
United States of America	973,569	7,034,386	12,244,184
Cuba	31,937	693,405	327,452
Mexico	78,383	495,341	499,730
Colombia	46,692	335,998	320,751
Venezuela	411,387	4,004,683	3,581,989
Peru	20,136	416,129	323,487
Chile	66,916	502,366	922,650
Brazil	57,148	888,950	778,780
Uruguay	10,316	63,499	78,846
Argentine Republic	211,327	3,382,283	1,994,160
Other foreign countries	373,730	4,025,629	3,869,195
TOTAL	20,394,365	182,983,251	191,029,250

TABLE 3.—SOURCES OF ELECTRICAL IMPORTS

Country	Month of October, 1959	Ten months ended 31st October, 1958	Ten months ended 31st October, 1959
	£	£	£
Australia	73,874	558,165	423,348
Canada	75,818	807,079	886,483
Other Commonwealth countries	232,115	1,128,063	1,540,482
Irish Republic	146,294	746,593	936,386
Sweden	70,012	927,633	967,191
Denmark	80,218	475,419	544,847
Western Germany	731,065	4,658,025	6,238,600
Netherlands	657,407	3,438,830	5,138,589
Belgium	33,962	464,105	425,329
France	229,533	1,047,557	1,482,597
Switzerland	141,612	1,250,796	1,435,628
Italy	103,957	653,736	885,667
United States of America	1,133,047	6,512,234	9,288,273
Other foreign countries	222,386	1,359,797	2,277,297
TOTAL	3,931,300	24,028,032	32,470,717

took 35 per cent more and Australia (£2·4 million) 25 per cent more. The Netherlands (£2·8 million) remained the biggest market.

Shipments last month of large transformers valued at just over £1 million brought the total for the group, which also covers converting machinery and switchgear, to above the 1958 level for the first time this year. India, Australia and Rhodesia are among the countries to which exports have increased. Though total exports of generators and motors were still less than a year ago, more were exported in October than in September and markets to which there have been increased shipments this year include South Africa, India, Australia and the United States. Exports of telephone and telegraph equipment and wires and cables fell in October, and the ten months totals were below last year's figures.

Exports to the larger Commonwealth countries, except Canada, continued to improve, and those to Western Europe and the United States have been well maintained. In October there was a marked increase in shipments to Venezuela, though the ten months' total was still some £400,000 below the 1958 level.

Electrical imports last month rose by £200,000 to £3·9 million. Taking September and October together, imports averaged £3·8 million or 46 per cent more than in the corresponding months of 1958. Imports from all the major suppliers except Australia and Belgium have increased this year.

TABLE 4.—OTHER ELECTRICAL AND ALLIED EXPORTS

Class	Month of October, 1959	Ten months ended 31st October, 1958	Ten months ended 31st October, 1959
	£	£	£
Washing machines, electrically operated:			
Not exceeding 150 lb weight	324,725	3,307,947	2,876,619
150 lb to 250 lb	61,055	773,954	499,053
Parts	86,218	819,789	793,660
Electric locomotives (incl. battery types)	374,956	2,848,169	4,636,351
Diesel locomotives with electrical transmission	318,094	1,614,808	2,951,802
Welding electrodes:			
Ferrous	145,452	876,278	925,953
Non-ferrous	16,817	275,686	212,675
Electric conduit tubes and cased tubes	71,613	559,818	606,122
Electric carbons	149,600	504,178	1,051,783
Electric lighting fittings and lanterns (excl. arc lamps, searchlights and cycle lamps)	388,286	3,063,299	2,946,699
Electric fork-lift trucks	93,707	663,023	746,320
Steam turbines (excl. marine)	811,982	6,019,488	9,009,683
Water turbines	302,147	2,130,602	3,346,353

TABLE 5.—ELECTRICAL IMPORTS

Class	Month of October, 1959	Ten months ended 31st October, 1958	Ten months ended 31st October, 1959
	£	£	£
Generators, incl. parts	96,697	768,388	751,533
Motors, incl. parts	144,529	934,146	1,271,177
Convertors; transformers; rectifiers*	132,059	335,406	948,732
Switchgear and switchboards (not telegraph and telephone)	87,066	528,692	916,858
Cathode ray tubes, complete	155,726	427,854	1,455,110
Other valves, complete*	294,322	1,782,518	2,437,324
Parts (excl. glass bulbs)*	104,822	369,356	722,298
Radio receiving sets, domestic or portable	55,586	159,364	308,558
Radio communication and navigational aids, complete	453,932	2,998,885	3,956,636
Other radio and TV apparatus, parts and accessories	350,078	3,296,007	3,334,338
Apparatus for telegraphy and telephony	35,586	1,136,393	850,499
Welding machinery	70,466	289,786	550,181
Cooking and heating apparatus	186,858	1,255,764	1,409,141
Magnetos, ignition, and electric appliances for aeroplanes, motor vehicles and cycles	213,532	2,162,282	1,837,162
Electro-medical apparatus (incl. X-ray apparatus)	76,765	616,903	847,954
Portable mechanical appliances, electrically operated, complete	137,572	884,008	1,127,672
Parts	73,970	686,933	550,311
Scientific electrical instruments (excl. telegraphic and telephonic)	227,411	1,544,577	1,496,003
Other machinery, apparatus and appliances	1,034,323	3,850,770	7,699,230
TOTAL	3,931,300	24,028,032	32,470,717

* The figures for 1959 are not completely comparable with those for 1958.

Building Exhibition

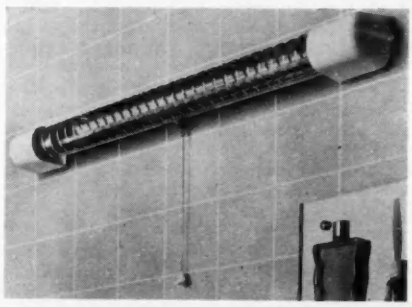
THE number of electrical firms exhibiting at the Building Exhibition now being held at Olympia, London (18th November to 2nd December), is comparatively small. This does not mean that electricity, and the part that it plays in the mechanisation of the building industry, is not in evidence, but after a visit to the exhibition it is felt that the electrical industry could be more adequately represented. Electric floor warming, for example, which is now in use more and more as a means of heating in blocks of flats, offices, etc., is represented by only two concerns—Falk, Stadelmann & Co., Ltd., who demonstrate the "Florawarm" floor warming cable, and the B.I.C.C. Panelec Heating Division, who exhibit several examples of their radiant floor warming systems.

The stand of the Electrical Development Association, however, places special emphasis on floor warming and half the space, in fact, is devoted to the subject. An eye-catching display focuses attention on its many merits —stressing its cleanliness, efficiency and low cost of installation. A circular platform divided into sections with different floor coverings (wood block, carpet, tile, etc.) has cut-away ends which reveal the floor warming cables and demonstrate the system's suitability for almost any floor covering.

Another section of the E.D.A. stand, which is devised throughout to show how successful the all-electric house can be, stresses standards for adequacy of wiring, while another display shows the advantages of the electric hot water system.

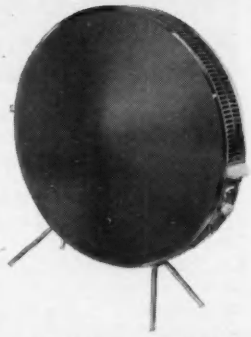
Heating in another form can be seen on the Dimplex stand where examples from the company's range of heating appliances are shown. The display includes portable infra-red fires in loadings of 750 to 1,500 W and several types of oil-filled electric radiators and towel rails. Also of interest on this stand are the company's skirting board styled convector heaters available in 2ft (300 W) and 3ft (500 W) sizes which can be used either as portable heaters or for mounting direct on to skirting boards or walls.

Ekco Heating (E. K. Cole, Ltd.) exhibit for the first time a new range of unit heaters for providing large volumes of warmed air for factories, warehouses, large shops, etc. They have loadings of 3, 5 and 10 kW and each model can be controlled by remote switching. The company's "Thermovent" convector heaters and an attractive new type WM convector for wall mounting use are shown, as well as several radiant type fires. Included among the last-named types is the 750 W "Firestreak" wall mounting infra-red heater, which is now available with a cord pull switch. A "Twinstreak" suspension model (1½ kW) is available for industrial applications.



Ekco "Firestreak" 750 W infra-red fire with cord pull-switch

Both panel and column type oil-filled electric radiators are displayed on the Hurseal stand. We were told that radiators are now available to any length to fit the full window width or can be made angled or curved to fit into bays. A recently developed technique of combining a hot water and electric oil-filled radiator is reported by Hurseal to be proving popular. By this means the normal heating system can be boosted in very cold weather.



Sofono "Spacemaster" 2 kW convector heater

Whilst still on the subject of heating, it was interesting to note that on the stand of Federated Foundries—a name that has for many years been associated with "Sofono" non-electric inset fires, back boiler flue sets, etc.—a new range of electric convectors and radiant fires were displayed. The new appliances consist of two "Spacemaster" 2 kW convector heaters, one of which has a built-in 750 W reflector fire. Thermostatic control is provided for the convection element, and the heaters, of an unusual circular shape, are obtainable in a range of duo-tone colours (1 kW models are also available). Reflector fires (also in 1 and 2 kW sizes) with adjustable angle reflectors are shown.

New items shown by Electrix, Ltd., include a neatly styled 1½ kW screen fire, an oil-filled electric towel rail and a drying and airing cabinet. The new drying cabinet, model 306, has a front opening door and 18ft of plastic-covered clothing rails. The maximum loading is 1,250 W.

What is claimed to be an entirely new system of lightweight trunking is shown on the Siemens Ediswan stand. Designed to carry overhead lighting, this "Liteline" trunking is exceptionally rigid and allows long economical spans. Any size of network can be built up from the 15ft steel channel sections available and fittings can be attached to any point by means of special self-locking bolts, through which cable can be fed directly into the wiring ducts above.

Among an array of fluorescent tubes and tungsten lamps, the new Siemens straight 200 W linear sodium lamp, which promises a 25 per cent gain in efficiency over conventional U-shaped types, was noted.

Atlas Lighting, Ltd., have on show for the first time their new "Chelsea" range of hand-wrought English glassware lighting fittings. The various units cover a wide range of different colours and designs and all are interchangeable, offering the interior designer an entirely new medium. Apart from these fittings, Atlas show several other lighting examples, including a new fluorescent tube—the "De Luxe Natural." The colour rendering properties of this tube are claimed to be particularly suitable in food display lighting.

Although used extensively on the Continent for many years, the "Isora" illuminating and insulating ceiling is

An example of the use of an "Isora" illuminated ceiling fitted with A.E.I. 8ft fluorescent fittings

new to this country. The stand of S.F.I.M. (Great Britain), Ltd., illustrates some of the advantages of this product, as well as a new lighting fitting specially designed for the "Isora" ceiling by the A.E.I. Lamp & Lighting Co., Ltd. The ceilings are normally built up from 4oin sq steel frames covered with translucent or opaque p.v.c. in a range of colours and patterns. The weight is 14 oz/sq ft and they are claimed to provide thermal insulation without loss of existing natural daylight. Ideal applications are said to exist in factories, showrooms and commercial premises.

A suspended illuminated ceiling is also to be seen on the Falk, Stadelmann stand, where, in addition, the company's "Olympus" range of domestic lighting fittings is displayed.

Refrigerators are, surprisingly enough, not very much in evidence. Easiclene Porcelain Enamel, Ltd., have three new models on view—the "Two-Five," "Four-Two" and "Five-Two," while Electrolux, Ltd., show their popular M.27 built-in refrigerator. Being a fixture, it is generally possible to include the cost of a built-in refrigerator in a mortgage and these models are being used by large numbers of builders and local authorities.

Electrolux model M.27 built-in refrigerator

Rawlplug type R.P.2 drill

Visitors to the 1955 exhibition may remember an early example of heat pump which was produced. This year, English Rose Kitchens, Ltd., are showing on their stand a model which is claimed to provide hot water for bathroom, sink and hand-basins; 6 cu ft of refrigeration space; and cooling air to the kitchen when required. The total loading of this model is 2,800 W.

A two-speed "Rawlplug" electric drill, the RP.2, is being demonstrated for the first time. This appliance, which is virtually two drills in one, obviates the need to maintain another tool for low-speed masonry drilling. The lower speed of 420 r.p.m. is ideal for this type of work, while its 1,200 r.p.m. speed is suitable for all normal drilling work. The change-over is effected by a simple push/pull button.

"Power Tool Productivity" is the theme of Bridges' stand where nearly every model on show now incorporates the "Neonic Safety Eye." Now, with the introduction of their paint spray attachment, Bridges claim to be the first power tool manufacturers to provide for every stage of home decorating.

Wolf Electric Tools show their new double-insulated general- and heavy-duty drills, as well as a new "Sandswift" orbital sander. The sander, which is demonstrated, weighs just over 7 lb and is robustly constructed for continuous day-to-day use. In the woodworking machinery section of the exhibition a number of companies show their latest developments. Electrically-operated bandsaws, veneer presses and many other machines with special fittings for particular jobs can be seen in actual working conditions.

In the contractors' plant and machinery section, W. C. Youngman, Ltd., demonstrate a new method of cleaning the face of buildings, making use of electrically-operated power staging. At the touch of a button the operator can ascend or descend at will.

Fuel Economy Through Automatic Operation

WITH the above title as its general theme, a conference was held at Scarborough on 3rd and 4th November by the Combustion Engineering Association. Apart from a civic reception by the Mayor and Mayoress of Scarborough and a dinner under the presidency of Mr. S. P. Chambers, C.B., chairman of the conference, the main events were the presentation of the following four papers:—"Fuel and Ash Handling," by F. S. Stent (Babcock & Wilcox, Ltd.); "Combustion and Mechanical Firing," by M. V. Murray (Wm. Cory & Son, Ltd.); "Automatic Control Equipment," by J. S. Hales (British Coal Utilisation Research Association); and "Present Day Practice in Automatic Control," by I. W. Stevenson (Kelvin & Hughes, Ltd.).

INDUSTRIAL NEWS

Outer Seven Agreement

The convention of the European Free Trade Association was initialed on 20th November by the Ministers of the Outer Seven countries, Austria, Denmark, Norway, Portugal, Sweden, Switzerland and the United Kingdom. It was insisted at the ministerial meeting that the E.F.T.A. is only a first step towards the aim of forming a wider free trade area, incorporating all the O.E.E.C. countries.

The convention, the full English text of which should be available on Monday, provides for a first cut in tariffs on industrial goods of 20 per cent on 1st July, 1960, and for the process of the elimination of tariffs to be completed in steps of 10 per cent by 1st January, 1970. Quantitative import restrictions will also be removed progressively by this date. Rules have also been agreed covering dumping, export subsidies and restrictive practices.

The tariff cuts will apply to all industrial goods wholly produced in one of the Outer Seven countries, to certain others containing some manufacturing process which is undertaken in a member country and which qualifies the products for inclusion, and to other products in which the component materials imported from outside the free trade area account for 50 per cent or less of the final export price.

Domestic Refrigerator Sales

The Domestic Refrigeration Development Committee states that 77,106 domestic refrigerators were sold during September, more than twice as many as in September last year (33,294). Total sales for the last nine months, 683,016, show an increase of 98 per cent over the corresponding period of 1958. The demand began early in the year with January sales 150 per cent up on last year. This reflects a significant change in the seasonal pattern for the domestic refrigeration industry which, up to now, has had to plan for a demand which reached its peak during the summer months—particularly during May and June—followed by a severe drop during autumn and winter.

Bearings Companies' Agreement

The Timken Roller Bearing Co. and the Fafnir Bearing Co., of New Britain, Connecticut, U.S.A., have announced that an agreement will shortly be concluded by which a recently formed subsidiary of the latter, Fafnir Bearing Co., Ltd., will purchase the business of the Fischer Bearings Co., Ltd., a Timken subsidiary. The sale of the business of the Fischer Bearings Co. results from the Timken decision to confine its interest to the manufacture of tapered roller bearings throughout the world. It will, however, continue for the present, to distribute F.B.C. bearings for replacement purposes in Britain, through its subsidiary Timken stockists, and in Australia, South Africa and Canada, through its branches in those countries. It is intended that Fafnir's British products will be marketed under the Fafnir name. Mr. S. M. Cooper, chairman of Fafnir, will become chairman and managing director of the English company and will be assisted by Mr. W. L. Hubbard.

Transformers for Nigeria

For the transmission scheme in the western region of Nigeria, Ferranti, Ltd., has received an order from the Electricity Corporation of Nigeria for transformers valued at over £70,000. The order covers the supply of three 12·5 MVA units, 132/11 kV fitted with resistor type on-load tap changing gear; one 5 MVA unit, 132/33 kV fitted with resistor type on-load tap changing gear; and one 33 kV earthing transformer. The consulting engineers are Messrs. Preece, Cardew & Rider.

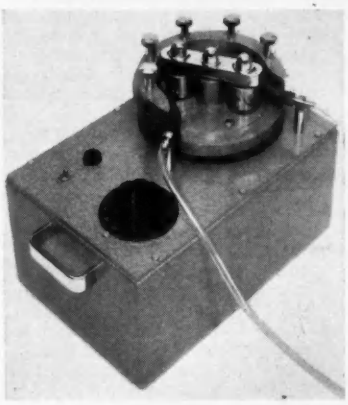
German Computer Mission's Visit

The recent progress made by British manufacturers of computers is to be demonstrated between 30th November and 4th December to a West German mission representing, among others, the universities and the coal, steel, chemical, glass and motor industries, food distribution, airline, shipping, insurance and banking companies. The visit is organised by the Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association with the co-operation of the Board of Trade and the British Embassy in Bonn. The mission will visit computer demonstration centres, factories and places where they are in use in the London area and in Manchester. It will be entertained at a British Government reception at which the Minister of State, Board of Trade, Mr. F. J. Erroll, M.P., will be host at Lancaster House on the evening of their arrival and there is to be a reception at the German Embassy at the conclusion of the tour. The members of the mission will be welcomed at the Park Lane Hotel on the arrival of Mr. V. M. Roberts, O.B.E., chairman of the Joint Committee of the Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association.

Blood Pump

New advances in open heart surgery are being made at a London hospital involving the cooling of patients down to very low temperatures (profound hypothermia). By this means the metabolism of the brain is slowed down so that its oxygen requirements are reduced to a very low level. In fact, the patient's temperature is reduced from 36°C to 14°C, at which point the blood circulation can be completely stopped for up to an hour. Siemens Edison Swan, Ltd., is making roller-type pumps which are used to force the blood into the lungs for oxygenation while the patient's temperature is being reduced. Blood is also pumped through a heat exchanger which cools the blood before surgery commences and warms it up afterwards to revive the patient.

This roller-type blood pump is designed for controlled flow rates of from 0 to 6 litres per minute with negligible hæmolysis. The replaceable



Siemens Ediswan roller blood pump for open heart surgery

pump element is a translucent rubber tube held securely in position by a positive clamp, the tube being cheap enough to be discarded and replaced by a new one after every operation. The flow rate is governed by the speed of rotation of the roller arm, and this can be varied smoothly from 0 to 200 r.p.m. The equipment is both simple and reliable, and embodies a handle for manual operation in the event of a mains failure.

Cables Over School Grounds

In the Court of Session, Edinburgh, on 20th November, Lord Cameron refused to order the North of Scotland Hydro-Electric Board to delay switching on high power electric current to cables running across the grounds of Rudolf Steiner School, Newtondee, Aberdeenshire.

Camphill (Rudolf Steiner) Schools, Ltd., 2, Bon Accord Square, Aberdeen, had asked the court for an interim interdict, complaining of "grave danger" to their 75 pupils, who, they feared, would be tempted to climb the

pylons and touch cables carrying 132 kV with fatal consequences. The work of erection was complete and all that remained was to switch on the current.

Lord Cameron, giving judgment, said it was not suggested that there was any omission to provide safety devices, nor had there been any instance of children climbing similar pylons in the area. But according to pursuers this was the only case in Britain of h.v. cables being carried across school grounds. The pursuers might have a case of nuisance against the Board, said Lord Cameron, but the only question he had to deal with meantime was whether the pursuers were entitled to the interim remedy they sought. Their apprehension was certainly deserving of serious consideration. However, there were no concrete facts of past experience to show that the risks which the pursuers feared had ever shown signs of maturing in the case of pylons carrying h.v. cables but protected with anti-climbing devices. The Board had pointed to the past immunity of its transmission lines and the need for the supply of electricity to areas for which it was responsible.

Lord Cameron said he considered he was entitled to take into account the responsibilities of the Board as a public authority. The pursuers' fears had also been considered at a public inquiry which preceded the ultimate granting by the Secretary of State for Scotland of consent to the erection of the lines over the present route. In the whole circumstances, the pursuers had failed to show sufficient reason to warrant interference with the Board's plans for completing its present works. The balance of convenience was in favour of refusing interim interdict.

The pursuers were granted leave to appeal.

Changes in F.B.I. Committee Structure

Important changes in the permanent committee structure of the Federation of British Industries have been approved by the F.B.I.'s Grand Council. They come into effect immediately, and are designed to facilitate the study of problems of growing concern to industry.

A Committee on Policy Towards the Under-Developed Countries will meet under the chairmanship of Sir Leslie Rowan, Finance Director of Vickers, Ltd. An Export Promotion Policy Committee, which will advise the F.B.I. on all aspects of export promotion and on the direction, method and timing of special activities, will have Sir Leslie Gamage, M.C., chairman of the General Electric Co., Ltd., as its chairman. An Overseas Credit and Investment Committee, meeting under the chairmanship of Sir Henry Wilson Smith, replaces the F.B.I. Panel on Overseas Credit and Investment which was set up earlier this year to make recommendations on export credit facilities to the Chancellor of the Exchequer and the Exports Credit Guarantee Department.

Terms of reference of the existing F.B.I. Location of Industry Committee have been revised, and it is now paying particular attention to Government activity in connection with the Local Employment Bill. The constitution of other F.B.I. Standing Committees will remain unchanged, except that the Company Law, Patents and Trade Marks Committee will now concentrate on Company Law alone, with special reference to the working of the Companies Act.

Part of the showroom at the new premises opened by H. F. Scriven, Ltd., at Bute House, Bute Street, Luton

Hotpoint Conference

A.E.I.-Hotpoint, Ltd., met 250 Hotpoint dealers from all over Britain at Brighton on 10th and 11th November. They were welcomed at the Metropole Hotel by Mr. R. Craig Wood, managing director. There were marketing presentations in the form of talks by the marketing managers of the home laundry and portable appliance groups, followed by the introduction of the 1960 "Iced Diamond" refrigerator by Mr. J. Parkin, refrigerator marketing manager. Mr. J. D. Lake, general sales manager, briefly summed up the afternoon's activities to conclude the programme. A reception in the evening was followed by a formal dinner and a cabaret.

Safety and Health in Non-Ferrous Foundries

The second report of the Joint Standing Committee on Safety, Health and Welfare Conditions in Non-Ferrous Foundries has been published by the Ministry of Labour (H.M. Stationery Office, 1s 9d net), and is devoted to known and potential health hazards in non-ferrous founding. The Committee is of the opinion that the report on known risks prepared by its Technical Sub-Committee, to whom the question of health risks was remitted, "warrants the close attention of the industry" which it is urged should act on it as soon as possible. Attention is drawn to a medical appendix covering both known and potential risks, and the Committee comments that a "good knowledge of this part would result in the avoidance of many risks which might be introduced inadvertently with new processes." The Committee agrees with its Sub-Committee in its view that medical supervision is desirable wherever it can be arranged, and that a general medical survey of the industry would help greatly by establishing the type and magnitude of the health risks involved.

Remploy Report

Sales in the year ended 31st March last reached an all-time record of £4,178,000, stated Sir Alec Zealley, chairman of Remploy, Ltd., at the company's annual meeting held on 18th November. The company is a national organisation employing the severely disabled, and has ninety factories in England, Scotland and Wales. Sir Alec said that the increase of nearly 11 per cent on the total for the previous year had been realised despite difficult trading conditions in the first half of the year. The company had also been faced with a continued decline in Government orders received for its industrial clothing and specialised packaging factories.

Although production and sales had broken all records, inflationary effects had submerged this achievement. As a result, the operating loss had increased by £90,000 to £2,812,000. Current sales were now running at a rate of well over £5 million annually. Unless there was a reversal of the movement toward national economic stability, he looked forward to a better financial result next year. Speaking of the social value of Remploy, Sir Alec said that for the annual expenditure of something over £2½ million, 6,200 men

and women who would otherwise have had practically no hope of finding jobs had been kept in productive employment. Steady progress had been made with sponsorship schemes, under which industrial concerns transferred part of their production to Remploy factories.

The Electrical Division, London, N.W.2, produces, among other appliances, electric soldering irons, oil-filled electric radiators and the "Chill-chaser" car and general purpose heater. Sponsorship schemes include electrical assembly work.

Electricity Supply Hours and Holidays

Consideration was given on 19th November by the National Joint Advisory Council for the Electricity Supply Industry to the claims of the employees' representatives for a shorter working week and longer holidays. It was agreed by the Council that all employees with twelve or more years' continuous service would be given an extra week's paid holiday and those with seven years' service an extra day with a further day for each year of service in excess of seven.

The question of a shorter working week was referred to a special sub-committee, composed of five representatives of each side of the Council, which is to report to the Council in January.

Following an unofficial call for action over the treatment of the claims, power station workers at Battersea and Kingston-on-Thames began to work to rule on Monday and overtime was banned. Similar action was subsequently taken at the Marchwood and Blackwall Point stations.

Mr. R. G. Cook, industrial officer, National Union of General and Municipal Workers, said that the holidays agreement represented the best in any major section of British industry. Any unofficial action was to be deprecated.

Greater Silicon Supplies

The General Chemical Division of Imperial Chemical Industries, Ltd., announces the completion of extensions of its Merseyside silicon plant. The capacity will be increased by 4,000 lb a year and the price of silicon will be lowered.

Equipment for B.B.C.

A contract to the value of about £115,000 has been placed by the British Broadcasting Corporation with Marconi's Wireless Telegraph Co., Ltd., for the supply of television translators, low power television transmitters and amplifiers and frequency-modulated sound translators and amplifiers. The equipment will be used to extend the coverage of the B.B.C. television and v.h.f. sound broadcasting services.

Television translators pick up signals—both vision and sound—from another television station, amplify them and re-transmit them on new frequencies. The low power transmitters are used where direct pick-up from an existing station is not possible. These accept the vision and sound signals at video and audio frequencies—usually over coaxial cable—and transmit them from a point within the area of indifferent reception. The frequency-modulated translators will carry out a similar function for the B.B.C.'s v.h.f. sound service.

Hackbridge Holdings, Ltd., Acquisition

Hackbridge Holdings, Ltd., has purchased for cash all the issued share capital of London Transformer Products, Ltd., which has works at Willesden and Bridgend. The range of transformer products manufactured and marketed by London Transformer Products is substantially complementary to, and not in competition with, that of the transformer and capacitor unit of Hackbridge Holdings (Bryce Electric Construction Co., Ltd.). The board is as follows:—Messrs. A. L. Foulger (chairman), H. S. Lyle, A.M.I.R.E., F. S. Lyle and W. G. Crocker, A.C.G.I., D.I.C., M.I.E.E.

American Plant in Scotland

The Hughes Aircraft Co., Culver City, California, has announced that it has received permission from the Board of Trade to establish an electronics manufacturing plant at Glenrothes, Fife, Scotland. The factory, which will be built by Glenrothes Development Corporation to Hughes' specifications, is scheduled to begin production by September, 1960, on semiconductor devices and allied electronic components.

Patents Delegation to Russia

After we had gone to press last week we were informed that since the chairman of the U.S.S.R. Committee on Inventions and Discoveries had been unexpectedly called away from Moscow for a short period, the visit of the United Kingdom delegation had been postponed for a week and was to leave for Moscow yesterday (Thursday).

Laurence, Scott Ex-Apprentices

Laurence, Scott & Electromotors, Ltd., would like to hear from ex-apprentices with whom they have lost touch. It is hoped to arrange for a get-together, possibly during the run of the Electrical Engineers Exhibition next year. Ex-apprentices are asked to give details of their present whereabouts, either to Mr. W. F. Symes, Gothic Works, Norwich, or by telephone to Mr. T. J. Barfield at Temple Bar 5223.

Birmingham Intercommunication Equipment Exhibition

A two-day exhibition of intercommunication equipment is to be held by Siemens Edison Swan, Ltd., at the Queen's Hotel, Birmingham, on Monday and Tuesday next. The equipment to be displayed will include a cordless telephone switchboard, the "Herald-a-phone" internal telephone and public address system, the silent call telephone, and a range of private telephone exchanges, switchboards, office intercoms and staff location systems.

Klystrons for U.S.A.

The English Electric Valve Co., Ltd., announces that Collins Radio Co. has placed a $100,000 order for their klystron type K350 which will be used in American-built Doppler navigation equipment.

Ideal Home Exhibition

The *Daily Mail* Ideal Home Exhibition of 1960 will be held, as usual, at Olympia. It will open on 1st March and close at 10 p.m. on 26th March.

Educational

A course of ten lectures on "Linear and Non-Linear Servo Control" will be given by Mr. J. Sands at the South East London Technical College, Lewisham Way, S.E.4, on Wednesday evenings, commencing on 20th January. The fee for the course is £1 and particulars can be obtained from the Principal of the College.

The National Institute of Industrial Psychology, 14, Welbeck Street, London, W.1, has issued its programme of courses for the period January to April next.

Trade Announcements

E.C.C. Moulded Breakers, Ltd., announces the appointment of Mr. F. Mather, formerly of E. N. Bray, Ltd., as sales engineer attached to the Lancashire area offices at 16, John Dalton Street, Manchester, 2, and also Mr. D. R. Booth, formerly of Enfield Cables, Ltd., as sales engineer domiciled at the company's southern counties area offices at Bushbury House, 57, Buckingham Gate, London, S.W.1.

The **Consolidated Pneumatic Tool Co., Ltd.,** is opening a new district office on 1st December at 1, Bedminster Down Road, Bristol, 3 (telephone: Bristol 63736), under the management of Mr. J. D. Glover. Its operations will cover the counties of Somerset, Devon, Cornwall and part of Gloucester. The branch office at Bridgend, Glam., which previously served this area will continue to operate as the south western district for the South Wales counties, Hereford and part of Gloucester.

Meritus (Barnet), Ltd., has opened a welding demonstration workshop at its factory at Barnet, Herts. A comprehensive range of its welding machines can be seen and demonstrated at any time.

The Birmingham office of **Keith Blackman, Ltd.,** is moving on 4th December and will be operating from 7th December from 1651, Pershore Road, Birmingham, 30 (telephone: Kings Norton 4151/2).

GENERATION and DEVELOPMENT

Industrial Areas Still Set the Pace

Electricity Boards serving mainly industrial areas continued to show a higher rate of expansion in October than those with primarily non-industrial consumers, though the difference was not as great as in the previous month. The Electricity Council's return gives the average output increase of the former as 7·2 per cent and of the latter as 5·1 per cent. The Yorkshire and South Wales Boards made most progress with gains of 10·2 and 8·2 per cent respectively.

A total of 9,050 million kWh was generated last month by the Central Electricity Generating Board, the South of Scotland Electricity Board and the North of Scotland Hydro-Electric Board, the increase of 5·7 per cent being slightly below the annual average. More electricity was available, however, from the United Kingdom Atomic Energy Authority's stations, which in the four weeks ended 31st October generated 110 million kWh against only 13 million in the corresponding period of 1958. This figure is included in the Ministry of Power's separate statement of generation by industry which also shows increases in most of the industrial classifications.

At the end of October the total capacity of generating plant installed in public supply stations was 29,608 MW. New plant commissioned by the C.E.G.B. included a 200 MW English Electric set and a 1,400 klb/hr International Combustion boiler at High Marnham and a 60 MW C. A. Parsons set and 550 klb/hr Foster Wheeler boiler at Little Barford "B." The North of Scotland Hydro-Electric Board installed an 11 MW English Electric set at Cashlie power station and a 256 kW Armfield Hydraulic Engineering Co. compensation set at Orrin.

Tariff Prospects in the Midlands

Members of the Midlands Electricity Consultative Council, at their meeting at Oldbury on 16th November, were told by the chairman of the Board (Mr. W. S. Lewis) that "except for unforeseen circumstances there is a chance that in my time as chairman there will not be any increase in the tariffs we are at present operating. I think we can look forward to a period of stability that will help industry, domestic consumers and everyone."

Asked by the deputy chairman of the Council, Councillor H. Preece, if he could envisage any lowering of tariffs, Mr. Lewis replied that, if prices outside their control remained stable, then he could frankly look forward to a reduction, particularly in the running cost of electricity.

Mr. H. J. Gibson, chief commercial officer, said he thought the trend would be for the "unit" price to fall, but with rising consumption the Board would have to spend a great deal more money on reinforcing the distribution system. On this point the chairman of the Board remarked that the average consumption by domestic consumers had risen by 200 kWh in a year and said that if that trend continued the more they reduced running costs the more they would have to face reinforcement to deal with the load. At present 48 per cent of capital was raised out of revenue, but they must not place too much of a burden on the present generation of consumers.

Councillor E. Seymour-Williams said he thought Mr. Lewis's statement about the possibility of stable tariffs should be given the widest publicity. If people knew that electricity tariffs would not go up it might prevent them from going over to oil-fired heating appliances.

South Wales Board's Activities

Mr. H. Pryce-Jones, deputy chairman of the South Wales Electricity Board, said at a recent meeting of the Area Consultative Council that the Board's surplus for 1958-59 was below the national average because a great deal of system improvement work had had to be undertaken. One of the main problems had been to ensure a good supply voltage, mainly for television sets, but fewer complaints were now being received. Going on to talk about economy measures, Mr. Pryce-Jones said that the staff had been reduced by 599 in the period between March and the end of September, mainly due to natural wastage. Introduction of mechanical accounting had saved £100,000. He announced that the Board's Sub-Area offices at Newport were to be replaced by new offices at Cwmbran.

New Hull Grid Supply Point

Reference was made in last week's issue to the grid supply point opened by the Deputy Lord Mayor of Hull (Alderman L. Science) on 3rd November at Somerden Road, Marfleet. The substation has been established to cater for the large industrial and housing estate loads in the area. It is fed from the C.E.G.B. Yorkshire Division's Creykebeck supply point by a double-circuit 132 kV overhead line. These circuits are controlled by air-

ELECTRICITY GENERATED AND SENT OUT FOR PUBLIC SUPPLY

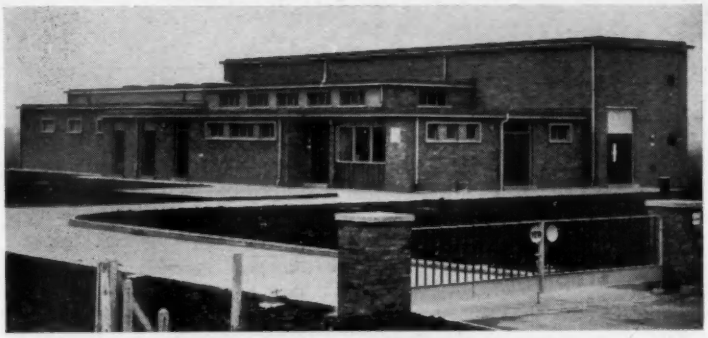
	Fuel consumed Thousand tons			kWh generated Millions			kWh sent out Millions	Installed capacity (m.c.r.) MW
	Coal	Coke and Breeze	Oil	Steam	Water power	Total		
Central Electricity G.B.	3,565	90	368·7	8,334	3	8,345	7,835	26,795
North of Scotland H.E.B.	17	—	1·2	32	148	185	183	1,042
South of Scotland E.B.	260	4	0·7	500	20	520	490	1,771
Total for October, 1959	3,842	94	370·6	8,866	171	*9,050	8,508	29,608
Corres. total for October, 1958	3,746	97	312·8	8,320	235	8,565	8,066	27,369
Inc. or dec., per cent	+2·6	−2·9	+18·5	+6·6	−26·9	+5·7	+5·5	+8·2
Total to date (10 months), 1959	36,196	944	3,328·0	82,104	1,558	83,768	78,776	
Total for corres. 10 months, 1958	36,745	817	1,882·0	77,283	1,725	79,131	74,430	
Inc. or dec., per cent	−1·5	+15·6	+76·8	+6·2	−9·7	+5·9	+5·8	

* The total figure includes generation by other methods amounting to 13 million kWh.

ELECTRICITY SENT OUT BY AREA BOARDS FOR THEIR CONSUMERS

Board	Totals for October (million kWh)			Twelve Months Totals Ended 31st October (million kWh)		
	1958	1959	Inc. or Dec. %	1958	1959	Inc. or Dec. %
London	651·4	664·8	+ 2·1	7,593·4	7,908·4	+ 4·1
South Eastern	443·7	477·2	+ 7·6	5,114·5	5,448·0	+ 6·5
Southern	581·7	620·8	+ 6·7	6,468·1	7,085·7	+ 9·5
South Western	268·9	285·3	+ 6·1	3,128·2	3,340·7	+ 6·8
Eastern	713·8	747·7	+ 4·7	8,120·4	8,629·8	+ 6·3
East Midlands*	601·8	634·9	+ 5·5	6,754·2	7,221·3	+ 6·9
Midlands*	785·1	842·9	+ 7·4	8,763·6	9,449·6	+ 7·8
SouthWales*	452·6	489·9	+ 8·2	5,027·1	5,315·5	+ 5·7
Merseyside and North Wales*	466·5	500·0	+ 7·2	5,293·5	5,614·1	+ 6·1
Yorkshire*	747·7	824·3	+10·2	8,609·3	9,088·0	+ 5·6
North Eastern*	439·7	470·5	+ 7·0	5,052·7	5,333·2	+ 5·6
North Western*	787·4	825·2	+ 4·8	8,938·6	9,272·9	+ 3·7
Total all Area Boards	6,940·3	7,383·5	+ 6·4	78,863·6	83,707·2	+ 6·1
Direct Supplies by C.E.G.B.	261·1	311·5	+19·3	2,892·9	3,334·7	+15·3
Grand Total	7,201·4	7,695·0	+ 6·9	81,756·5	87,041·9	+ 6·5
Mainly Industrial Areas*	4,280·8	4,587·7	+ 7·2	48,439·0	51,294·6	+ 5·9
Mainly Non-Industrial Areas	2,659·5	2,795·8	+ 5·1	30,424·6	32,412·6	+ 6·5
South of Scotland E.B.	575·4	606·4	+ 5·4	6,523·1	7,019·9	+ 7·6
North of Scotland H.E.B.	124·8	129·4	+ 3·7	1,512·9	1,589·3	+ 5·1

* Those in which industrial consumers took over 50% of the total sales in the preceding financial year.



General view of the new Hull East grid substation

blast circuit-breakers at Creykebeck and are connected at Hull East through air-break isolators. The equipment at the new substation includes two 45 MVA, 132/22 kV grid transformers in the C.E.G.B. compound and two 12·5 MVA, 22/11 kV units in the Yorkshire Electricity Board's compound, all being of the outdoor oil-filled type. The 22 and 11 kV controlling switchgear is contained in brick-built switchrooms. Provision has been made for a substantial increase in the grid transformer capacity and for a number of additional outgoing 22 and 11 kV circuits.

The principal contractors for the electrical equipment were as follows:—132 kV overhead lines, Pirelli-General Cable Works; 132 kV outdoor equipment and 22 and 11 kV switchgear and control equipment, A.E.I. Switchgear Division (Ferguson Pailin); 132/22 kV grid transformers, Hackbridge & Hewittic Electric Co.; 22/11 kV transformers, A.E.I. Transformer Division (Metropolitan-Vickers). The substation was designed by the Chief Engineer's Department of the Yorkshire Electricity Board in collaboration with the Engineering Departments of the head office and Yorkshire Division of the C.E.G.B. and Messrs. Merz & McLellan, acting for the Generating Board.

Meters Too High

The Metropolitan Boroughs' Standing Joint Committee recently drew the attention of the London Electricity Board to the difficulty experienced by old people when prepayment meters were installed too high for them to reach. In reply, the Board has stated that it cannot give a general undertaking to move all meters free of charge, but will deal sympathetically with cases of hardship.

Cumberland Overhead Line

The North Western Electricity Board has completed the erection of a 33 kV overhead line from Penrith (Cumberland) to Alston, where a new substation has been built. The line is intended to reinforce the existing supply in the Alston area and to meet the needs of the Alston Foundry Co., which uses an electric arc furnace for steel-making. Although the line is overhead at present, the Board has given an undertaking to the Council for the Preservation of Rural England that it will be placed underground during the next ten years.

Severn/Wye Crossing Inaugurated

The 275 kV transmission line across the Rivers Severn and Wye (see *Electrical Review*, 25th September, page 359) was officially inaugurated on 16th November. Owing to ill-health Lord Brecon, who was to have performed the ceremony, was unable to attend and Mr. Blaise Gillie, Welsh Secretary, Ministry of Housing and Local Government and Welsh Affairs, deputised for him. Mr. Gillie said that the new service would make it much easier for industrialists to build new factories where they were needed —in the areas where a high rate of unemployment existed or was threatened. It would also be a very great boon to the farmers and the villagers in rural areas.

Power Lines Near Post Office Circuits

When high voltage overhead lines or underground cables are routed close to Post Office wires or cables there is a risk of contact with, or inductive interference to, Post Office circuits. Under the Electric Lighting (Clauses) Act, 1899, the Postmaster General has powers to protect the Post Office lines against such contact or interference. A revised memorandum (A231) has now been issued dealing with the precautions that must be taken when new power lines are provided. The memorandum has already been sent to Divisions of the Central Electricity Generating Board and to Area Electricity Boards. Consulting engineers and others concerned with this work may obtain copies on application to the Post Office Engineering Department, Cn Branch (Cn2/2/1), 2-12, Gresham Street, London, E.C.2.

Future of Halifax Power Station

Halifax Health Committee has been told by the town clerk that in two years' time the power station in Foundry Road will cease generating electricity and will become a substation. Residents and shopkeepers in the Northgate area have complained of smoke and condensation from the station.

Higher River Crossings

We said in our 13th November issue that the Midlands Electricity Board had decided to raise all power lines over the Rivers Severn and Avon to a minimum height of 45ft. We are now informed that while this is true of the Avon the question of crossings over the Severn is still being negotiated.

OVERSEAS

New Street Lanterns for Australia

To illuminate the main highway linking the Australian seaside resort of St. Kilda with Melbourne the Export Division of Thorn Electrical Industries, Ltd., is to supply 500 Atlas "Alpha Three" lanterns. The "Alpha Three" is a tropically tested lantern designed to accommodate the new 250 and 400 W MBF/U fluorescent mercury lamps. Careful attention has been paid to the optical system which falls within the category of a medium angle beam lantern and has excellent cut-off characteristics. The development of this lantern follows the successful "Alpha One" sodium lantern, embodying the hermetically sealed "Opticel" which ensures that the internal parts of the lantern are always clean, thus giving maximum light output. With the 400 W MBF/U lamp, the lantern gives an illumination of 10,640 lumens per 100ft of roadway at 120ft spacing. The light output ratio of the lantern is 0·78 and only 2 per cent is emitted above the horizontal.

The Atlas "Alpha Three" lantern for 250 and 400 W MBF/U fluorescent mercury lamps

Large Gas Turbine Station

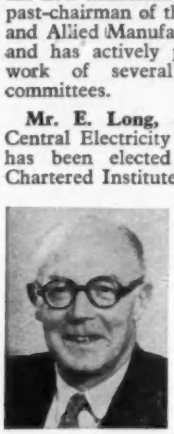
A gas turbine power plant, said to be the largest of its kind in the world, has recently been brought into operation at Port Mann, British Columbia, by the B.C. Electric Company. The 134,000 h.p. station is controlled automatically from the load dispatch office in Vancouver. Either gas or oil can be used as fuel.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

Col. B. H. Leeson, C.B.E., T.D., having resigned the chairmanship of the British National Committee of the International Electrotechnical Commission (I.E.C.), **Mr. J. O. Knowles,** M.I.E.E., a director of Metal Industries, Ltd., has been elected as the new chairman. Mr. Knowles is a past-chairman of the British Electrical and Allied Manufacturers' Association and has actively participated in the work of several I.E.C. technical committees.

Mr. E. Long, a member of the Central Electricity Generating Board, has been elected president of the Chartered Institute of Secretaries. He assumes office on 1st January next in succession to **Mr. J. Davison,** managing director of De Havilland (South Africa), Ltd. A former secretary of the Central Electricity Authority, Mr. Long was educated at Carlisle Grammar School and served in local government posts. He was borough treasurer of Luton in 1935, of Finchley in 1936 and became city treasurer of Newcastle-upon-Tyne in 1942. He served as deputy chief accountant, British Electricity Authority, from 1948 to 1951. He was secretary of the Institute of Municipal Treasurers and Accountants from 1944 to 1948, and chairman of the Council of the Institute of Public Administration in 1949 and 1950.



Mr. E. Long

The Chartered Institute of Secretaries also announces that one of the vice-presidents for 1960 is **Mr. S. M. Rix,** deputy chairman of the Southern Electricity Board.

Mr. C. P. Paton has resigned from the board of the Northern Aluminium Co., Ltd., and is taking up a position with Aluminium, Ltd., of Canada, in Montreal. **Mr. T. Cornelius,** who has taken over from Mr. Paton as the Northern Aluminium Co.'s general works manager, has been elected a director of the company.

Mr. Tibor Haas, Dipl.Ing., A.M.I.Mech.E., A.F.R.Ae.S., has been appointed head of the Design Section in the newly formed Members' Service Department of the British Welding Research Association.

The Court of the **Worshipful Company of Tin Plate Workers** has again decided to offer at least twelve travelling scholarships for 1960, each to the value of £50, on the same general terms and conditions as last year, with the additional requirement of a short statement in the candidate's handwriting giving his reasons for his application.

Mr. A. C. Stapleton has been appointed to the board of the Yorkshire Factoring Co., Ltd. He has been assistant to Mr. F. Walters, managing director, for many years.

Mr. R. F. Markham, A.M.I.E.E., Bedford district manager of the Eastern Electricity Board, is retiring at the end of November but his services are being retained in an advisory capacity until the end of the year. He will be succeeded by **Mr. R. H. G. Worboys,** at present the district engineer at Stevenage.

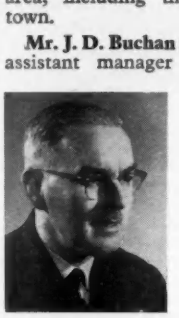
Mr. Markham commenced his career with the St. Marylebone Electricity Department. Subsequently he served with Brown Boveri & Co., following which he was an assistant engineer on the staff of Kincaid, Waller, Manville & Dawson, consulting engineers for the electrification of the London, Brighton and South Coast Railway. In 1916 Mr. Markham joined the Royal Flying Corps, and after the war he returned to the railway for a short period and was then appointed an engineer in the Sales and Contracting Department of Johnson & Phillips, Ltd., a position which he held for nineteen years. At the outbreak of the last war he joined the Burton-upon-Trent Corporation Electricity Department and in 1948 was appointed Burton sub-area engineer with the East Midlands Electricity Board, later becoming district manager at Bedford.

Mr. Worboys was apprenticed to the North Metropolitan Electric Power Supply Co. and this was followed by an appointment as a junior engineer at Hertford. In 1928 he went to Royston as an assistant engineer and became sales engineer and later assistant district superintendent, following which he was appointed district engineer at Letchworth and then took over the combined district when Letchworth and Stevenage were merged. At Stevenage he has been responsible for providing and maintaining electricity to a rapidly growing area, including the Stevenage new town.

Mr. R. F. Markham

Mr. R. H. G. Worboys

Mr. J. D. Buchan has been appointed assistant manager of the Publicity Department of the Metropolitan-Vickers Electrical Co., Ltd. Mr. Buchan joined the Metropolitan-Vickers Co. in 1928, working first in the Swansea office under Sir Arthur Whitten Brown. He transferred to the head office of the Lamp and Lighting Department, London, in 1936, and in 1938 joined the Publicity Department, Trafford Park, to handle Lamp and Lighting Department publicity. Resuming this work after five years' service in the R.A.F., he was later concerned additionally with publicity for the Heating and Welding Department; Newton Victor (the company's X-ray Department); and Scientific Apparatus Department. Mr. Buchan is hon. secretary of the Lancashire section of the Incorporated Society of British Advertisers.



Mr. J. D. Buchan

The Simplex Electric Co., Ltd., announces that **Mr. C. D. Braithwaite** and **Mr. T. E. Trotman** have been appointed joint marketing managers, Creda Division, responsible for the direction of all sales promotion and marketing of Creda products. Mr. Braithwaite will be responsible for the marketing of Creda products to the Electricity Boards, and Mr. Trotman for the marketing of products to all other outlets. **Mr. M. H. Barnes** has been appointed product manager (home laundry) and **Mr. L. F. Dowling** product manager (refrigerators).

Mr. J. C. C. Whyte, formerly technical representative for the West Midlands and Mid-Wales areas of W. H. Allen, Sons & Co., Ltd., Bedford, has been appointed manager of the company's new central counties branch office at Lloyds Bank Chambers, 85, Regent Street, Leamington Spa, opened recently. A staff of engineers will operate from the new office, covering the Midlands, Cheshire, Lancashire, Yorkshire, the Western Counties and Wales.

Mr. T. C. Standeven has been appointed general manager of the Radio and Television Division of Ultra Electric, Ltd. He has for the

past eighteen months been the commercial manager of the Radio and Television Division, and since last April this has incorporated the activities of Pilot Radio & Television, Ltd. **Mr. L. R. Crawford** has joined the company and has been appointed general manager of the Special Products Division.

Mr. G. M. Ingram, A.M.I.E.E., has been appointed branch manager of the Manchester office of the Brush Electrical Engineering Co., Ltd., from 1st December. He was educated at Wellington and Loughborough and joined the Brush Co. as a student apprentice in 1940. He spent four years as the company's representative with its agents in India, and has also represented the company in Iran. Since November, 1955, Mr. Ingram has been branch manager at the company's Sheffield office.

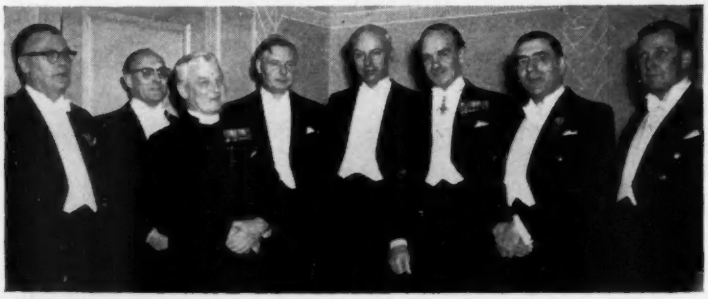
Mr. R. Atkins succeeds Mr. Ingram as branch manager at Sheffield. He served his apprenticeship with Stewarts & Lloyds, Ltd., Corby, and in 1946 joined the Brush Co. as a special trainee and was employed in the switchgear division until 1953, when he transferred to the Birmingham office as sales engineer.

Mr. G. M. Ingram

Mr. R. Atkins

Prof. G. W. Carter, Professor of Electrical Engineering at Leeds University, and chairman of the **I.E.E. North Midland Centre,** presided at the annual dinner of the Centre held at the Queen's Hotel, Leeds, on 20th November. Major-General E. S. Cole, Director of Telecommunications at the War Office, proposed the toast to the Institution and the North Midland Centre and commented on the necessity for close liaison between the technical staff of the Forces and the Institution, from whom he considered it was essential that the maximum assistance should be given in order to keep the Defence Forces in the front line of technical knowledge. In responding, Mr. A. H. Mumford, vice-president of the Institution, pledged the Institution to give this support. The toast to the guests was proposed by Prof. Carter, and the Very Rev. F. Llewelyn Hughes, Dean of Ripon, responded.

At the I.E.E. North Midland Centre Dinner. Left to right: Mr. A. J. Coveney (past chairman, North Midland Centre), Mr. W. J. A. Painter (senior vice-chairman), the Very Rev. F. Llewelyn Hughes (Dean of Ripon), Mr. J. D. Nicholson (immediate past chairman, North Midland Centre), Prof. G. W. Carter (Centre chairman), Major Gen. E. S. Cole (Director of Telecommunications, War Office), Mr. A. H. Mumford (vice-president of the Institution) and Dr. G. N. Patchett (vice-chairman, North Midland Centre)



Mr. Arthur H. Young, A.M.I.E.E., F.I.E.S., joint managing director of Troughton & Young, Ltd., left on 15th November for a short tour of the British West Indies, the United States and Canada in connection with the

At the ladies' night of the A.S.E.E. Golfing Society. Left to right: Mr. B. W. Ricks, Mrs. Ricks, Mrs. Kelly, Mr. C. Penny (hon. secretary), Mr. W. S. Kelly, Lady Eccles, Mrs. Penny and Sir Josiah Eccles

Mr. A. Barton has been appointed works manager of Opperman Gears, Ltd., Newbury.

The annual prizegiving for the apprentices of **Hoover, Ltd.,** Perivale, Middlesex, was held on 18th November. Capt. J. F. Fuller, O.B.E., warden of the Outward Bound Sea School at Aberdovey, addressed the boys and presented the prizes. The works manager's shield for the best all-round apprentice of the year was won by Phillip King, while Barry Hall won the craftsmanship prize.

The ladies' night of the **A.S.E.E. Golfing Society** was held recently at the Café Royal, London, when members and their guests spent an enjoyable evening under the chairmanship of the captain, Mr. W. F. Parker, M.I.E.E. The guests of honour were Sir Josiah Eccles, president of the A.S.E.E., and Lady Eccles, and Mr. C. G. F. Aldridge, national chairman of the A.S.E.E., and Mrs. Aldridge.

We regret that in the caption to the picture in our last issue of Sir George Nelson making a presentation at the annual presentation of awards to apprentices of the **English Electric Co.,** we incorrectly stated that he was presenting the foremen's shield to John C. Robinson. The picture showed Sir George making a presentation to final year technician apprentice Keith E. Owen, one of the two highest award winners.

Mr. Ian R. Galloway has been appointed manager of the South Eastern Electricity Board's Guildford District in succession to **Mr. W. E. Affleck,** who is retiring early next year. Mr. Galloway was educated at Daniel Stewart's College and Heriot-Watt College, Edinburgh. He began his career with the Lothians Electric Power Co., becoming substations engineer. During the war he was attached to the Department of Anti-Submarine Warfare, Admiralty, and then spent a year with Klaxon, Ltd., as technical sales engineer. In 1947 he was appointed assistant mains superintendent with Kirkcaldy Corporation, became district engineer, Kirkcaldy, in 1948 and three years later joined Seeboard as first assistant engineer, Central Sussex District. He moved to Brighton and Hove in the same capacity in 1953 and was appointed district engineer in 1956.

Mr. I. R. Galloway

interests of the company and associated companies in these territories.

At the end of this month **Mr. R. J. Horlock** will leave the export department of John Thompson, Ltd., to manage the Group's new branch office in Buenos Aires, Argentina. Mr. Horlock has been with the John Thompson Group for twenty-five years. Before returning to Wolverhampton earlier this year he was for eleven years contracts engineer at the Group's Calcutta office, from where for some time he supervised site constructions in India.

Mr. R. J. Horlock

Mr. A. H. Mumford, O.B.E., B.Sc.(Eng.), M.I.E.E., Deputy Engineer-in-Chief of the G.P.O., has been appointed Engineer-in-Chief in succession to **Brig. Sir Lionel Harris,** who is retiring on 31st January. **Capt. C. F. Booth,** C.B.E., M.I.E.E., is appointed Assistant Engineer-in-Chief, and **Mr. D. A. Barron,** M.Sc., M.I.E.E., Assistant Engineer-in-Chief, is to be Deputy Engineer-in-Chief from 1st February.

Mr. Mumford was educated at Bancroft's School and Queen Mary College (London University). He joined the G.P.O. in 1924 as assistant engineer, Radio Branch, Engineer-in-Chief's Office, and was appointed executive engineer in charge of the radio laboratory at Dollis Hill in 1933, being promoted to assistant staff engineer two years later. He became staff engineer in charge of the radio development branch in 1938, Assistant Engineer-in-Chief in 1951 and Deputy Engineer-in-Chief in 1954. Mr. Mumford is a vice-president of the Institution of Electrical Engineers and was chairman of the Radio Section in 1945-46. A photograph of him with others taken at the North Midlands Centre dinner of the Institution appears in this section.

The B.B.C. announces the appointment of **Mr. G. Dukes** as engineer-in-charge of Les Platons television transmitting station, Jersey, Channel Islands, in succession to the late Mr. J. J. Allen.

In our last issue we reported the appointments of **Mr. H. Jaggers** as chief engineer of Tricity Cookers, Ltd., and **Mr. K. E. Chad** as chief designer. We have since received their portraits which we now reproduce.

Mr. H. Jaggers

Mr. K. E. Chad

Mr. F. A. Ross, Mr. W. G. A. Jenkins and **Mr. J. Higginbotham** have been appointed directors of Edgar Allen & Co., Ltd. Additional changes in the constitution of certain subsidiary companies are also to be made, and will be announced shortly.

Mr. A. L. Stock has resigned from the position of chairman and director of Lodge Plugs, Ltd., and **Mr. V. Martin-Jones** has been appointed chairman of the company. **Mr. F. E. V. Spencer** becomes managing director and **Mr. J. Walker** a director. Mr. Walker is also a director of the Morgan Crucible Co., Ltd.

Dr. A. H. M. Arnold has been given the title Professor of Electrical Engineering in the University of London in respect of his position at King's College.

Mr. J. A. Robbins, B.Sc., M.I.E.E., A.M.I.Mech.E., who writes in this issue on "Earth-Leakage Circuit-Breakers" (page 739), received his technical education at the Rugby College of Technology and Arts. In 1945 he was appointed chief planner, control gear factory, British Thomson-Houston Co., Ltd., and from 1947 to 1950 he was in charge of the company's Lutterworth works. He then joined the Chilton Aircraft Co., Ltd., as works manager and in 1953 became technical sales manager for Chilton Electrical Products, Ltd., taking up his present position of circuit-breaker sales manager with J. A. Crabtree & Co., Ltd., Walsall, in 1956.

Mr. J. A. Robbins

Mr. Robbins is a member of the B.S.I. Miniature Circuit-Breaker and Earth-Leakage Circuit-Breaker Sub-Committees and also of the B.S.I. Code of Practice Drafting Committee on Earthing. He is chairman of the B.E.A.M.A. Earth-Leakage Circuit-Breaker Technical Committee and a member of their M.C.B. Technical Committee, and is well known as a lecturer on earthing and earth-leakage protection.

OBITUARY

Mr. Harold Patten, late sales manager of the Electric Construction Co., Ltd., Wolverhampton, died after a long illness on 13th November at the Overton Grange Nursing Home, Ludlow. The funeral service at Bushbury Crematorium, Wolverhampton, on 17th November was attended by directors, management and staff colleagues.

Mr. Patten joined E.C.C. in 1900, transferring to the Estimating Department in 1902, where he was associated with the late Mr. Will M. Furniss, an association which continued for half a century. He became head of the Estimating Department in 1915 and sales manager in 1942, an appointment which he held until his retirement in March, 1951, owing to ill-health.

Mrs. S. Z. de Ferranti.—The death occurred on 16th November of Mrs. Gertrude Ruth de Ferranti, the widow of Dr. S. Z. de Ferranti, F.R.S. She was in her ninety-first year.

Mr. O. Ellefsen.—In last week's issue we recorded the death, on 14th November, of Mr. Ole Ellefsen, A.M.I.E.E. Mr. Ellefsen had been associated with the Morecambe Electrical Equipment Co., Ltd., for twenty-seven years, being managing director from 1941 to 1955, since when he had continued to serve as a director of the company.

Mr. Algernon Southern, chairman and managing director of Southern & Redfern, Ltd., Bradford, electrical, mechanical and refrigerating engineers, died recently in his 60th year after a short illness. Mr. Southern was a founder member of the firm which started as A. Southern & Co. in 1924.

Lady Railing.—It is with regret that we have to record the death of Lady (Clare) Railing, O.B.E., wife of Sir Harry Railing, former chairman of the General Electric Co., Ltd., which occurred on 18th November.

WILLS

Mr. F. T. Jackson, O.B.E., chairman of Telephone Rentals, Ltd., and chairman and managing director of the Telephone Manufacturing Co., Ltd., and founder of both companies, who died on 14th August last, left £183,176 gross (£161,815 net).

Mr. D. H. Bishop, late city electrical engineer, Dundee, who died on 23rd June last, left personal estate in England and Scotland valued at £45,081.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £180 0s 0d
COPPER, H.C. Electro	ton £238 0s 0d
Fire Refined 99·70%	ton £237 0s 0d
Fire Refined 99·50%	ton £236 0s 0d
COPPER Tubes ..	lb 2s 3½d
Sheet	ton £266 5s 0d
H.C. wire and strip ..	ton £292 15s 0d
LEAD, English ..	ton £70 15s 0d
Foreign	ton £69 0s 0d
MERCURY	flask £71 10s 0d
TIN, block (English) ..	ton £791 10s 0d
ZINC, G.O.B. Foreign	ton £92 10s 0d
BRASS Tubes (solid drawn)	lb 1s 11d
Wire	lb 2s 9½d
PHOSPHOR BRONZE Wire	lb 4s 1½d
PLATINUM ..	oz £28 10s 0d
RUBBER, No. 1 R.S.S. spot	lb 36½d—37½d

Names of Famous Companies to Change

A.E.I. REORGANISATION COMPLETED

ON 1st January, the British Thomson-Houston Co., Ltd., Metropolitan-Vickers Electrical Co., Ltd., and Siemens Edison Swan, Ltd., will change their names to Associated Electrical Industries, Ltd., but they will be respectively distinguished by the suffixes Rugby, Manchester and Woolwich. Under their new titles the three companies will cease to trade, but each will instead be responsible for the management of a group of Product Divisions. From the beginning of the year also the number of Product Divisions of A.E.I. will be increased from seven to twelve. The new Divisions cover cables, construction, telecommunications, radio and electronic components, and instrumentation.

The Instrumentation Division combines the interests of Sunvic Controls, Ltd., with the instrumentation and meter, X-ray and scientific apparatus departments of Metropolitan-Vickers and will be managed by Associated Electrical Industries (Manchester), Ltd. This company also manages the Turbine, Switchgear, Transformer and Traction Divisions.

The other four new Divisions will be managed by Associated Electrical Industries (Woolwich), Ltd. The Cable Division and Construction Division combine the interests of the former S.E.S. Cables Division with those of W. T. Henley's Telegraph Works Co., Ltd., and Liverpool Electric Cables, Ltd. The Telecommunications Division and Radio and Electronic Components Division have previously traded as a Product Division of Siemens Edison Swan.

Birlec, Ltd., will be renamed A.E.I.-Birlec, Ltd., and will be managed by Associated Electrical Industries (Rugby), Ltd. This company will also manage the Heavy Plant, Motor and Control Gear, and Electronic Apparatus Divisions and A.E.I. Lamp & Lighting, Ltd. A.E.I.-Hotpoint remains a separate entity responsible direct to Group headquarters and there are to be no changes in the organisation affecting the A.E.I.'s part in nuclear power construction. All employees are now transferred to A.E.I. employment.

Announcing the changes at a Press conference in London on Monday, Lord Chandos said the trade marks of these famous companies would continue to appear on certain products. It was felt that the Group would be in a better competitive position if it enjoyed, like its principal rivals, a unified structure and name. They hoped to gain economies from the reorganisation, Lord Chandos explained, because longer runs of products would be possible and because work on one-off jobs could be concentrated in specialised plant where it would cause less disruption. There would be little movement of production plant between the different areas as a result of the changes.

I.E.E. TRAINING REGULATIONS

THE Institution of Electrical Engineers has published regulations for the training of graduate and student apprentices. Details are contained in a publication "Training Regulations" issued under the authority of the Council, copies of which may be obtained on application to the secretary of the Institution, Savoy Place, London, W.C.2.

Much of the content of the regulations will not be new to those who have been concerned with the training of apprentices, but the document gives a concise explanation of the requirements of the Council. The regulations do, however, recognise that some electrical organisations are unable to offer a comprehensive apprenticeship. In such cases, effective training may be obtained by a junior engineer while holding a position on the staff of a chartered electrical engineer. The preferred methods of training remain graduate apprenticeship and student apprenticeship, the latter being most effective when accompanied by a "sandwich" form of education.

When a proposal for associate membership is submitted, one of the sponsors of the candidate must make a statement concerning his training. The new regulations permit the graduate member to obtain an official evaluation of his training as soon as he has completed it, and a form for his use is included as an appendix in the regulations. If the training undertaken satisfies the regulations, this fact will be registered and the candidate notified accordingly. If the training does not meet the requirements, the candidate will be told of the extent and nature of the deficiency.

The regulations define the phases of training required during apprenticeship. The first phase, basic workshop training, must allow the trainee to acquire a knowledge of the properties, uses, methods of handling and limitations of conducting, insulating, magnetic and structural materials. This phase may be covered by workshop training arranged within a university or college, or during long-vacation courses in industry. The second phase, general mechanical and electrical training, should provide opportunities for studying methods of development, design, manufacture and utilisation of electrical equipment and of electrical test practice. The third phase, directed objective training, will depend upon the nature of the first substantial appointment as an electrical engineer for which the trainee is being prepared.

The second phase must be carried out under actual working conditions and should preferably include a period in a manufacturing organisation. By the end of the second phase, the trainee should have decided upon the type of engineering work for which he is best suited. The final phase of the training should therefore be directed towards this objective and must provide suitable training in allied work and should give opportunities for the candidate to take responsibility under general direction.

HIGH-VOLTAGE INSULATORS

THE discussion of the paper "Research on the Performance of High-Voltage Insulators in Polluted Atmospheres," by J. S. Forrest, P. J. Lambeth and D. F. Oakeshott, before a meeting of the Supply Section of the Institution of Electrical Engineers on 18th November was opened by Mr. P. J. Ryle (Merz & McLellan). He agreed that semi-conducting glaze might be the ideal way of distributing the voltage over the string, but asked whether there had been any experiments on producing an insulating body material—ceramic, glass, or something unlike either—which would divide the voltage per unit of the string equally. The authors said little about why tension strings were so much better than suspension strings. Had trials been made to see how far it was possible to reduce the number of units in a tension string before its surge counts resembled those of a suspension string under the same conditions? In a typical 275 kV line, knocking off two units per string in the tension strings should save £100 a mile.

M. E. de F. Leroy (France) said that three successive stages were necessary in choosing an insulator design to cope with specified pollution. The first, the line test stage, could be carried out by equipping each of the three phases of the line with a different design of insulator and noting the annual number of flashovers in each phase. Reliable conclusions should be drawn, but the test took a long time and was limited to three insulators. Secondly, there was the station test stage with natural pollution. In the third stage, the laboratory test, conclusions could be based on time to flashover but doubts arose about the true nature of the polluted layer. The three stages were complementary and research should be conducted simultaneously on all three.

The authors' artificial salt pollution test was excellent, but not suitable for the study of industrial pollution. It was very important to reproduce the washing action of rain. The best method might be to use solid dust deposited on an insulator followed by a few minutes of artificial rain.

Mr. J. A. Broughall (British Transport Commission) described the plight of British Railways, who had to cope not only with industrial pollution but with that created by steam locomotives passing underneath the insulators and with the fact that the intervals between trains were insufficient to allow cleaning. They had therefore adopted a generous creepage distance, almost double that used on the French railways, and had had in operation for three years a test gantry by which they could grade insulators.

Correlation of Results Needed

Mr. E. F. Johnston (Pilkingtons) suggested that the results obtained at different testing stations should be correlated to make available a greater volume of experience. At his testing station, the deposit was under a third of the Croydon figure, but the atmosphere was much more acidic, and the more acidic the atmosphere the greater the conductivity of the deposit on the insulator. The authors' gap between 25 mA and 150 mA seemed too large; examination at 40 and 80 mA should give a more accurate comparison between similar designs. His station tested at 10, 20, 40, 80 and 150 mA.

Mr. D. H. Cherry (C.E.G.B.) followed compliments to the authors with the criticism that the scale of their work was far too small and that therefore it had not been systematic. It was still not known what was the best form for a given creepage or whether a cylindrical insulator was better or worse than a pedestal type.

Grease could never be more than a palliative; it would require several tons to deal with a 275 kV substation and it would have to be removed and replaced after two years. The high-capacitance insulator seemed promising and there were possibilities in semiconducting glaze if very considerable developments were made on the production side. The best possibility for higher voltages at the moment was to put the stations indoors, which could be done at relatively small cost.

Mr. N. G. Simpson (B.I.C.C.) admitted that grease was only a palliative, but described its successful use in two of the most difficult climatic areas in the world, Aden and Karachi, to put an end to outages on 33 kV and 66 kV lines. His company, he said, had been pursuing actively the development of glass fibre and resin mouldings for overhead lines and railway electrification to improve insulation and mechanical strength and achieve integration with the structural form.

Preventing Flashovers at Littlebrook

Mr. W. G. Todd (C.E.G.B.) referred to what had been done by the application of grease to cure flashover trouble at Littlebrook, where there were 768 post insulators and a large number of bushing insulators. The programme provided for cleaning half of them each year and re-greasing. They were removed and taken to a building in which there was a degreasing tank and a grease tank, heated by immersion heaters. The insulators were lowered into the hot cleaning solution and rotated in it for ten minutes and then taken to a store to cool; they could not be re-greased when hot. They were then put into the grease for 3-4 seconds, removed, and the rotation continued until the grease had set. Since doing this there had been no flashovers.

Dr. F. H. Last (C.E.G.B.) felt that the paper suffered from compression; five years of work had been got into a very small space. In a previous paper, Dr. Forrest had said that the performance of the tension insulator under polluted conditions was good because it had a uniform surface leakage path and became polluted uniformly; the voltage over the units and over the surface remained fairly uniform. To achieve satisfactory cap and pin units, the aim should be to achieve that intentionally, and Dr. Last had great faith in the development of semiconducting glaze. Care must be taken in reproducing salt conditions artificially not to devise a test which would give an over-designed insulator.

While agreeing that the cap and pin type string was superior to the rod type, Mr. G. B. Jackson (C.E.G.B.) pointed out that it had more joints in it, and pollution in the joints between insulators gave rise to radio and television interference.

Mr. N. C. Blythe (B.I.C.C.) said they had been surprised to find from a recent field survey that most of the troubles reported related to the metal parts and not to the porcelain or glass. In the case of one pin insulator line overseas, corrosion took place under the insulator where the pin entered the cement and was so severe that the insulators toppled off the line, but it was confined to the centre phase of the line and was evidently related to some electrical phenomenon.

Mr. J. R. Smith (C.E.G.B.) mentioned that on the 132 kV grid system 35 per cent of the strings were tension, while on the 275 kV, where duplicate tension strings were used, the proportion was about 50 per cent. He suggested that corrosion of the semiconducting glaze near the caps or pins could be alleviated by grease at the junction between the glaze and the metal parts. Mr. C. J. O. Garrard (G.E.C.) suggested that conducting glaze was a line along which progress could be made; he had had considerable success in applying it to the insulators of surge divertors.

Mr. D. F. Oakeshott and Mr. P. J. Lambeth replied to the discussion. Mr. Lambeth, referring to Mr. Ryle's point of the possibility of a semiconducting body, said that with high electrical resistivity it was very difficult to get the heat out of the inside of the insulator. He thought that 70 per cent of a suspension set leakage path length would be adequate for a tension set. One reason for the tension set being superior was better rain washing, and another that any arc which started on the surface tended to rise clear of the rest of the insulator.

350 MW Turbo-Generators for Drakelow

World's Largest Single-Shaft Machines

TWO 350 MW turbo-generators, worth some £5 million, have been ordered from the English Electric Co., Ltd., by the Central Electricity Generating Board for installation in Drakelow "C" generating station near Burton-on-Trent. These machines are the most powerful single-shaft generating units ever ordered in this country and they are believed to be the largest machines of their type planned for installation anywhere in the world.

The associated boilers are to be manufactured by John Thompson Water Tube Boilers, Ltd., and these will be of the reheat type producing steam at the rate of 2,450,000 lb/hr at 2,400 p.s.i. with primary and reheat temperatures of 1,055°F. The two boilers and their accessories will cost about £6 million. The condensing plant will be supplied by Hick, Hargreaves & Co., Ltd.

Drakelow "C" generating station will have an ultimate total installed capacity of about 1,500 MW. It is on the fringe of the East Midlands coalfield which is now a major source of the low-grade coal used for electricity production. There are already two post-war power stations on the Drakelow site: Drakelow "A" with a capacity of 240 MW, and Drakelow "B," which is at present in course of construction, with a capacity of 480 MW.

Design and Steam Conditions

The 350 MW turbo-generator consists of a three-cylinder 3,000 r.p.m. reheat turbine with quadruple exhaust arranged as a tandem compound unit coupled to a hydrogen/water direct cooled alternator. Solid couplings are employed between the cylinders, and each shaft is mounted on two main bearings so that the assembly and maintenance of the machine are kept as simple as possible. The general arrangement of the machine is thus similar to the 275 MW units at present in course of manufacture for Blyth "B" power station.

The turbine will operate with steam conditions of 2,300 p.s.i. and 1,050°F at the stop valve, with reheat steam returning from the boiler to the intermediate pressure cylinder at 1,050°F. The vacuum at maximum and economic rating is 28·7in Hg (bar 30in). To meet the specified high pressure and temperature requirements, the h.p. cylinder employs a double casing arrangement over the first stages, so that the expanded steam is passed over the outside of the inner casing on its way to the remaining stages. These combined features enable the pressure differences and operating temperatures in the metal to be reduced, compared with those applied to a single casing design.

Well-proven ferritic materials are used in these casings and stress levels are such as to keep creep deformation well within permissible limits. Castings are employed for the steam chests and cylinder casings as they provide a more uniform thickness of material and corresponding thermal response, thus avoiding transient distortion associated with temperature changes.

The intermediate pressure cylinder has a partial double-casing construction similar to that of the h.p. cylinder. The quadruple-flow l.p. cylinder is arranged in two double-flow l.p. casings, each casing exhausting to one of the two condensers forming the twin-condenser unit. The machines will be provided with automatic shaft gland sealing arrangements while electronic supervisory gear with centralised control will be used in the station to simplify control and to give better safeguards for reliability, particularly in relation to quick starting and running up to load.

Alternator Cooling

The alternator is of the direct-cooled conductor type, employing a water-cooled stator winding and a hydrogen-cooled rotor, the rated gas pressure being 45 p.s.i. On conventional solid conductor machines the practice of increasing the alternator gas pressure to obtain the economic advantages of machines of larger output has been extensively adopted for a number of years, but an economic limit is reached at about 30 p.s.i. In the case of direct-cooled machines, the economic limit is much higher and the output for a given machine size can be increased much more for a given increase in operating gas pressure.

The bled steam feed heating system, which is also being supplied by the English Electric Co., Ltd., will have seven stages made up of three surface type l.p. heaters, followed by a high level storage de-aerator of the direct contact type, and by three h.p. heaters of the surface type. The feed system employs dual pumping, the three high-pressure heaters being interposed between the booster feed pump and the main boiler feed pump. The contract includes main boiler feed pumps either driven by separate auxiliary steam turbine or variable-speed coupling from the main turbo-alternator shaft.

Expansion of Technical Education

THE main shortages in highly trained scientific and technical manpower in the United Kingdom are chemists, physicists, metallurgists and chemical, mechanical and, to a lesser extent, electrical engineers. This statement is contained in a UNESCO review of world-wide measures to increase the number of scientists, technologists and technicians ("Training of Technical and Scientific Staff," H.M. Stationery Office, 16s 9d) published last Tuesday. The survey was prepared for the 1959 Conference of the International Bureau of Education and covers 55 countries. A need to increase technical and scientific staff and, therefore, to increase the number and capacity of establishments offering education in these fields was found to be a universal problem.

The United Kingdom reported encouraging progress towards achieving the national targets for the output of scientists, technologists and technical staff in the later 1960s. At the professional level, the twin sources of supply are the universities, with greatly expanded scientific and technological facilities, and technical colleges through the rapid development of new advanced courses made possible as new buildings come into use with the fulfilment of the 1956-61 £85 million building programme for technical education. From negligible numbers in 1950, it was estimated that in the session 1958-59 7,000 to 8,000 students were enrolled in over 250 sandwich courses. The large majority of sandwich students in England and Wales are "works based."

Financial Section

STOCKS and SHARES

ALTHOUGH still very busy by any normal standards, the industrial markets of the Stock Exchange are less active than they were in the first month of dealings following the General Election, and the behaviour of prices has become more ragged. Buyers have turned noticeably more critical in their appraisal of ordinary shares, many of which are offering meagre returns on the basis of present dividends. Bouts of profit-taking have consequently been making a rather larger impression than before on the level of prices, although at the beginning of this week the undertone could still be described as firm.

Irregular Markets

Tendencies have been irregular throughout the list of electrical shares, although the losses have seldom been serious and there have been some good exceptions. Of the leaders, A.E.I. and English Electric were respectively 3s 3d and 2s lower, and Crompton Parkinson came back 1s, to 17s, on consideration of the annual report, in which more difficult trading conditions were envisaged for the current year. S. Smith shed 2s 3d to 18s 9d, having encountered profit-taking since the announcement of increases in earnings and dividends. J. Lucas went back from 67s to 63s 9d, but picked up to 65s 3d after references to good prospects in the annual report. Plessey eased to 43s, ex-dividend, despite the good profits statement.

Cable Shares

Interim progress reports published by British Insulated Callender's Cables and Johnson & Phillips have lately provided up-to-date information on the difficult state of affairs which accounts for the relatively cautious attitude of investments towards shares connected with the cable industry. In both statements, competition was said to have become even more acute during the course of this year, particularly since the break-up in May of trade associations. Of the two factors held by B.I.C.C. to be mainly responsible for these conditions, however, the directors believed that the problem of excess capacity was being overcome by degrees. It was to be hoped that the lack of mutual trust in the industry, and the wholly uneconomic conditions prevailing in some sections of it, would be replaced by keen and sensible competition.

B.I.C.C. Prospects

In his interim statement Mr. McFadzean, of B.I.C.C., enlarged upon the previously published sales and profits figures for the first half of this year, and reviewed prospects for the rest of the period. Even allowing for the inclusion of contributions this time from the two new members of the group, T.C. & M. and Scottish Cables, sales in the latest half year were better than in either of the halves of 1958, although the trading surplus was lower than the strictly comparable figure for the preceding six months. In the current half year, home business in products especially affected by

Price Changes in

Company or Board	Nom. Value	Middle price 23rd Nov.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1959 Highest	1959 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	81		3	3	3 14 0	81	77½
Brit. Elec. 1974/77	100	78		3	3	3 17 0	78	74½
Brit. Elec. 1976/79	100	81		3½	3½	4 6 6	81	77½
Brit. Elec. 1974/79	100	91½		4½	4½	4 12 9	91½	87½
Overseas Electric Supply								
Calcutta Elec.	£1	20/-	+6d	6·8†	7†	11 8 0	20/-	16/-
East African Power	£1	21/-		7½	8	7 12 6	22/6	19/3
Nigerian Elec.	£1	18/-		8	8	8 18 0	18/-	13/-
Perak Hydro-Elec.	£1	14/6		10	5	6 18 0	15/-	12/3
Electrical Shares								
Aberdare Holdings	5/-	17/6		17½	17½	5 0 0	18/9	15/6
Aerialite	1/-	8/3	−1/3	54	54	6 11 0	12/3	7/9
Allen, W. H.	£1	53/9		11	12	4 9 3	53/9	43/-
Allied Insulators	5/-	23/6		—	20‡	4 5 0	23/6	18/9
Anglo-Portuguese Tel.	£1	30/9		9	9	5 17 0	30/9	26/6
Aron Elec. Ord.	£1	46/3	−3/9	15	15	6 9 9	62/6	46/3
Assoc. Elec. Ord.	£1	61/3	−3/3	15	15	4 18 0	67/-	53/9
Automatic Tel. & El.	£1	81/3		17	17‡	4 3 9	82/6	71/3
Babcock & Wilcox	£1	43/6	−6d	13½	13	5 19 3	52/6	43/6
Bakelite	10/-	38/9	−3d	15	15	3 17 6	40/-	22/-
Baldwin, H. J.	2/-	2/6		20	—	—	3/-	2/-
Berry's Electric	5/-	30/6	+9d	10	20‡	3 5 6	31/-	7/3
Bowthorpe Holdings	2/-	10/3	−3d	25	27	3 3 6*	10/9	8/-
British Elec. Traction: Def. Ord. "A"	5/-	45/6	−1/6	25	35	3 17 0	47/6	35/6
B.I. Callender's	£1	52/6	−2/6	12½	13½	5 2 9	58/6	44/9
B.I. Callender's 6% Pref.	£1	21/-		6	6	5 14 3	21/-	19/9
British Thermostat	5/-	23/-		30	35	3 16 0*	28/-	18/6
British Vac. Cleaner	5/-	12/6	+1/6	10	7½*	3 0 0	12/6	4/6
Brook Motors	10/-	58/6	−6d	25	24½*	4 2 6	59/6	46/-
Bulgin, A. F.	1/-	11/6		45	50	4 7 0	11/6	6/9
Bulpitts	5/-	18/6		—	15	4 1 0	18/9	10/-
Burco Dean	5/-	19/6	+6d	22½	16*	4 2 0	19/6	12/3
Cable & Wireless: Ord.	5/-	18/6		10	10*	2 15 6	18/6	12/3
4% Loan	100	96		4	4	4 3 3	96	93
Chloride El. Storage "A"	£1	65/6	−2/-	17½	20‡	4 1 6*	72/-	43/8
Clarke Chapman	£1	56/3	−1/3	27½	13½*	4 17 9	66/3	52/6
Cole, E. K.	5/-	25/6		17½	20	3 18 6	25/6	17/3
Contactor Switchgear	5/-	14/9	+3d	14	14	4 15 0	16/9	12/-
Cossor, A. C.	5/-	7/3	−3d	Nil	5	3 9 0	9/-	6/3
Crabtree	10/-	46/3		20	20	4 6 6	48/9	28/-
Crompton Parkinson	5/-	17/-	−1/-	12	14	4 2 3	19/-	11/9
Davis & Timmins	5/-	22/-		18	20	4 11 0	22/-	14/6
De La Rue	10/-	64/-	−1/-	17½	20	3 2 6	66/-	30/3
Decca "A"	10/-	42/6	−1/3	43½	50	4 14 3*	44/3	33/3
Desoutter	5/-	31/-		32½	23½*	3 10 3	31/-	19/-
Dewhurst	2/-	9/6		20	20	4 4 3	9/6	7/3
Dictograph Tel.	2/-	10/-	+6d	20	20	4 0 0	10/-	7/-
Dubilier Condenser	1/-	5/3		20	25	4 15 3	5/6	3/3
Duport	5/-	21/6	+5/-	12½	17½	4 1 6	21/6	10/3
E.M.I.	10/-	77/6	+3/-	15	20*	2 11 6	81/-	48/-
Electrical Apparatus	5/-	13/6	+3d	14½	14½	5 7 6	16/6	13/-
Electrical Components	5/-	13/9	−3d	12½	15	3 12 9*	14/-	7/-
Elec. Construction	£1	35/-	−9d	8½	9	5 2 9	37/-	27/9
Elliott-Automation	5/-	28/-	−9d	—	10‡	—	30/6	16/9
English Electric	£1	44/3	−2/-	14	14	4 4 6*	48/9	37/10
English Electric 3½% Pref.	£1	13/6		3½	3½	5 11 0	13/6	12/3
Ericsson Tel.	5/-	27/-	−1/-	12†	13†	3 18 6	28/-	22/3
Ever Ready	5/-	25/-	−6d	20	27½‡	3 6 0*	28/-	13/3
Falk Stadelmann	£1	35/6	+6d	10	10	5 12 9	35/6	25/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend indicated.

present difficulties would not be satisfactory, but their proportion of total turnover was not substantial. For the whole of the year, the chairman expected the overall net profit to be much in line with that of 1958. In the market it is regarded therefore as a fair assumption that the present dividend rate of 13½ per cent is again likely to be comfortably within earnings available. The indicated yield of over 5 per cent on the £1 shares of the company, at a price of 52s 6d, is more than a full one per cent better than the average for the industrial market at the present time.

Electrical Investments

Company or Board	Nom. Value	Middle price 23rd Nov.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1959 Highest	1959 Lowest
Electrical Shares—continued								
G.E.C.	£1	43/6	−3d	10	10	4 12 0	48/-	31/3
G.E.C. 6½% Pref.	£1	23/-		6½	6½	5 13 0	23/-	20/3
General Cables	5/-	9/-		24	15	8 6 9	9/3	7/6
Greenwood & Batley	£1	115/-		20	30	5 4 3	115/-	75/-
Hackbridge Holdings	5/-	15/6	−9d	20	20	6 9 0	19/3	14/3
Hackbridge & Hewittic	5/-	15/-		20	20	5 0 0*	15/6	10/6
Head Wrightson	5/-	23/3	−6d	20	14‡*	3 0 3	26/-	16/6
Heatrae	2/-	9/6	−6d	20	20	4 4 3	10/-	7/6
Holophane	5/-	19/6		22½	26	6 13 3	20/-	14/9
Hoover	5/-	96/-	−2/-	50	60	3 2 6	98/9	55/-
I.C.I.	£1	55/6	−9d	12	8*	2 17 6	58/9	33/-
Intl. Combustion	5/-	35/-	−1/-	25	30‡	4 5 9	38/6	29/9
Intl. Computers & T.	£1	73/9	−2/3	—	8‡	2 3 6	78/9	57/6
Johnson & Phillips	£1	18/9	−2/3	5	5	5 6 9	30/6	18/3
Lancashire Dynamo	£1	47/6		11	12½‡	3 19 0*	48/9	31/6
Laurence Scott	5/-	18/9		15	15	3 9 0*	18/9	14/-
Lister, R. A.	£1	48/6	−6d	10	12½	5 3 0	50/6	32/9
Lucas, J.	£1	65/3	−1/9	10	12½	3 18 6	70/-	43/3
Marconi Marine	£1	42/-		10	10	4 15 3	48/6	40/-
Marryat & Scott	2/-	11/9		37½	22½*	3 16 6	11/9	8/6
Mather & Platt	£1	50/-		15	10‡*	4 5 6	51/6	41/3
Metal Industries	£1	67/-	−1/-	14	14	4 3 6	68/-	39/9
Midland Elec. Mfg.	£1	48/9		12½	10*	4 2 0	48/9	41/6
Morphy-Richards	4/-	32/6		20	25	3 1 6	34/-	18/-
Murex	£1	62/6		17½	15	4 16 0	62/6	42/-
Newman Ind.	2/-	3/6	+3d	10	10	5 14 3	3/6	2/3
Oldham & Son	1/-	3/-		17½	17½	5 16 9	3/3	2/6
Parsons, C. A.	£1	50/6	−2/6	7½	8½‡	3 4 6	58/-	45/9
Philips' Lamps	Fl.10	138/9	+6/3	14	14	1 18 0	139/6	88/-
Plessey	10/-	43/-x.d.	−2/9	20	13*	3 0 6	46/3	23/6
Pye	5/-	21/-	−1/6	12½	12½	2 19 6	22/6	13/9
Pyrotenax	5/-	47/6		—	34	3 11 6	47/6	33/9
Reliance Clifton	5/-	22/6	−6d	15	15	3 6 9	24/6	17/6
Reyrolle	£1	90/9	−9d	17½	17½	3 17 3	98/-	85/9
Rheostatic	4/-	12/-		12½	12½	4 3 3	12/-	8/3
Richardsons Westgarth	10/-	12/-	−3d	8½	8½	6 19 0	15/3	11/6
Simon-Carves	5/-	29/-	−1/-	25	25	4 6 3	32/-	28/6
Smith (England), S.	4/-	18/9	−2/3	12½	17½	3 14 9	21/-	11/6
Southern Areas	£1	14/6	−6d	Nil	Nil	Nil	15/-	10/6
Strand Elec.	5/-	17/9	+6d	15	20	5 12 9	18/-	8/6
Sturtevant	5/-	23/6		15†	15†	5 5 9	23/6	17/-
Sun Elec.	5/-	16/3		25	15*	4 12 3	16/9	8/3
Switchgear & Cowans	5/-	15/9		22½	15*	4 15 3	16/-	10/3
T.C.C.	10/-	57/6	−1/-	25	25	4 7 0	58/6	38/-
Telephone Mfg.	5/-	7/-		10	10	7 2 9	7/3	4/9
Telephone Rentals	5/-	20/-	−2/6	12½	12½*	3 2 6	22/6	11/9
Thompson (John)	5/-	20/-		25	25	6 5 0	25/6	19/6
Thorn Elec.	5/-	48/9	−1/3	17½	20	2 1 0	50/-	26/3
Thornycroft	£1	21/3	−2/-	7½	6	5 13 0	30/-	20/6
Tube Investments	£1	120/-	+1/3	17½	20	3 6 9	120/-	71/6
Vactric	5/-	43/-	−1/6	25	37½	4 7 3	46/6	26/3
Veritys	5/-	1/6		12½	2½	—	5/-	1/3
Walsall Conduits	4/-	14/9	−3d	22½	22½	3 9 3*	15/3	10/8
Ward & Goldstone	5/-	57/6		25	30	2 12 3	57/6	30/6
Watford	2/-	12/9	−6d	25	25*	3 18 6	14/9	7/6
Westinghouse	£1	51/9	−9d	10	10	3 17 3	53/9	39/6
West, Allen	5/-	14/6		12½	11‡*	4 0 6	14/6	11/9
Wolf Electric	5/-	9/3	−6d	10	10	5 8 0	9/9	7/9

J. & P. Dividends

For the past two years Johnson & Phillips have distributed single dividends of 5 per cent, and have decided recently that trading conditions do not justify a resumption of interim payments at this stage. In their statement, the directors described competition in many branches of the electrical industry as having developed for some months into a violent struggle for markets. Despite every effort to increase efficiency, selling prices for most of the group's products had been reduced so far as to leave very little margin of profit, and in some cases none at all. It was added, however, that demand for cables had been better than in 1958, and that a substantially higher volume of orders had been taken. The price of the £1 shares has eased to 18s 9d since the announcement.

E.M.I. Report

The 10s shares of Electric & Musical Industries rose from £3 to £4 during the fortnight or so preceding the appearance of the full annual report, and after a brief further advance on news of the proposed 50 per cent scrip issue became steadier later at around 77s 6d. A dividend on the increased capital of not less than 14 per cent is forecast. This would represent a moderate improvement on the 1958–59 payment, and produce a yield of 2¼ per cent on the shares at their present price, adjusted for the issue. Interest in Mr. J. F. Lockwood's review was drawn particularly to his opinion that while sales of gramophone records might well have reached the end of their rapid expansion phase, the demand for electronic capital goods, of which sales continued to increase throughout the recent recession, seemed likely to go on rising.

Elliott-Automation Issues

The 5s shares of Elliott-Automation were quoted a few pence lower, at 28s, after the company's announcement of a 4 per cent interim dividend; two capital issues; and a forecast of a 6 per cent final distribution on the capital so increased. Of the two issues, the first is to be a "rights" offer of one new 5s share for every five held at a price expected to be around 20s. The second is to be a free scrip distribution, in the same proportion, applicable to both old and new shares. Calculation of the prospective yield after such changes becomes complicated. On the basis of the present quotation, however, an "ex-all" price in the neighbourhood of 22s 6d may be tentatively envisaged. The total dividend would be equivalent to 9½ per cent on the capital ranking, and the degree of investment confidence in the future of electronics and automation would be denoted by a yield of 2 per cent.

REPORTS and DIVIDENDS

Tube Investments, Ltd.—The group trading profits for the year to 31st July last of £12,617,000 were approximately the same as for the preceding year (£12,579,244), but they include the profits of the British Aluminium Co. for seven months since acquisition and those of Reynolds T.I. Aluminium for a similar period following the purchase by Tube Investments of a controlling interest in the company. The directors state that there was a strong recovery in all sections of the group's activities towards the end of the year. This has been maintained and has since gained momentum. In so far as the results are comparable with last year, they indicate a reduction in earnings of approximately 10 per cent; this was attributable to lower capacity operation in general and also to the effect of a considerable volume of export orders accepted at narrow margins. As we reported in our issue of 6th November, it is proposed to pay a final dividend of 12½ per cent (against 10 per cent), making 20 per cent (17½ per cent) for the year.

Electric & Musical Industries, Ltd.—The main figures in the accounts for the year ended 30th June last were given in our issue of 2nd October.

With the full report and accounts now issued, Mr. J. F. Lockwood (chairman) reviews the activities of the group during the past year, in the course of which he says that the discontinuance of the manufacture of "His Master's Voice" and "Marconiphone" radio and television receivers at Hayes freed factory space which will soon be fully taken up by the growing business in electronic capital goods. A large part of the capital expenditure of over £1,000,000 spent in the United Kingdom has been required to meet the growing demand of business in electronics. After referring to the group's technical training schemes, the chairman deals with scientific research and mentions the rapid developments in their new coded stereo radio system and the closed circuit colour television camera. Valve research for the Government also increased, particularly in the field of high power klystrons. Work on stereophonic broadcasting has been proceeding at an increased level, and in their research on colour television for closed circuit applications they have developed a new camera, using their own vidicon camera tubes. The industrial applications of photoconductive cells are being investigated, and they have made substantial progress in the development of thin magnetic films as computer storage elements. High power klystrons, lower power klystrons, camera tubes, storage tubes and photomultipliers have been in the programme of research during the year. Mr. Lockwood reviews the activities of E.M.I. Records, Ltd., E.M.I. Electronics, Ltd., and E.M.I. Sales & Service, Ltd., and also the company's overseas interests.

Having regard to the increase which has taken place in the amount of capital employed in the business, and to the revaluation of freehold properties, the directors recommend that the sum of £3,018,989 (being as to £2,905,990 the amount standing to the credit of share premium account and as to £112,999 part of the amount standing to the credit of the reserve resulting from the said revaluation) should be capitalised and applied in paying up in full 6,037,978 ordinary shares of 10s each to be issued to ordinary stockholders in the proportion of one new share of 10s for every £1 of ordinary stock held. In addition to creating the shares required for the proposed issue the directors consider that additional share capital should be made available for issue as and when required in the future. They therefore recommend that the authorised share capital should be increased to £17·5 million by the creation of the 6,037,978 ordinary shares of 10s each required for the issue now proposed and of a further 2,481,011 unclassified shares of £1 each which (together with the existing 2,462,021 unissued unclassified shares of £1 each) the directors will be free to issue either as ordinary shares or with special rights. The directors have no present intention of issuing the balance of unissued capital. The new ordinary shares which, upon issue, will be converted into ordinary stock, will not rank for the final dividend to be declared in respect of the year ended 30th June last but they will rank in full for subsequent dividends. In the absence of unforeseen circumstances, the directors expect that it will be possible to distribute by way of dividend in respect of the current year not less than a total of 14 per cent on the ordinary capital as increased by the rights issue made in July last and by the issue now proposed. An extraordinary general meeting will be held on 10th December immediately after the annual general meeting, at which the necessary resolutions will be proposed.

Elliott-Automation, Ltd., is paying an interim dividend of 4 per cent (unchanged). The directors intend to issue further ordinary capital by way of rights to existing shareholders in the ratio of one new share of 5s for every five shares held and envisage the price of issue for these shares to be around 20s per share. The board also proposes to capitalise a part of the company's reserves and to issue new shares, free of cost, to shareholders on the basis of one new share of 5s in respect of every five shares held after the "rights" issue. An extraordinary general meeting will shortly be called to authorise an increase in the company's share capital and the proposed capitalisation of reserves. The shares arising from the two issues will not be eligible for the interim dividend now declared, but will rank *pari passu* with the existing shares for the final dividend in respect of 1959 payable in June of next year. It is the present intention of the directors to recommend a final dividend for the year to 31st December next of 6 per cent on the capital as increased by the two issues mentioned above.

The Sun Electrical Co., Ltd.—The net profit for the year ended 30th April last amounted to £60,885, as compared with £60,173 for the preceding year. Taxation absorbed £45,200. General reserve receives £15,000, and it is proposed to pay a final dividend of 12½ per cent (against 10 per cent), making 15 per cent for the year (against an equivalent of 12½ per cent), on capital doubled by a scrip issue. The balance carried forward is £194,759 (against £172,160 brought in).

Duport, Ltd., reports a group profit for the year to 31st July last of £2,068,960, as compared with £1,432,979 for the preceding year, and after deducting £1,021,523 for taxation and £8,159 for outside interests, there is a net balance of £1,039,278 (against £677,221). It is proposed to pay a final dividend of 12½ per cent (against 7½ per cent), making 17½ per cent (12½ per cent) for the year.

Scottish Cables (South Africa), Ltd.—The annual meeting was held at Pietermaritzburg on 20th November. In his review of the year Mr. W. Fraser (chairman) said that there was a steady level of demand throughout the year, and all sections of the factory operated at full load. Towards the end of the year the volume of available business showed a considerable deterioration and there was no evidence as yet to suggest that there would be any immediate upturn in demand for their products, and they were at present operating at a reduced level of output.

Referring to the merging of the associated company, Scottish Cables, Ltd., Renfrew, with British Insulated Callender's Cables, Ltd., Mr. Fraser said that a condition of the B.I.C.C. offer required that 160,000 ordinary shares in Scottish Cables (South Africa), which were held by the late chairman and himself, be made available for purchase by Scottish Cables, Ltd., Renfrew. This transaction was now being completed, following which Scottish Cables (South Africa) would become a subsidiary of Scottish Cables, Ltd. Their company would continue to operate as a separate entity.

Joseph Lucas (Industries), Ltd., report that with other income of £392,758, the trading profit for the year ended 31st July last is £7,651,377, as compared with £7,270,210 for the preceding year, and after providing £5,142,728 for taxation, the net balance

is £2,527,437 (against £2,241,956), of which £1,552,573 is dealt with in the accounts of the parent company. It is proposed to pay a final dividend of 10 per cent, making 12½ per cent for the year (against 10 per cent).

The Hackbridge & Hewittic Electric Co., Ltd., has declared an interim ordinary dividend of 4 per cent (against an equivalent of 3¾ per cent after allowing for a scrip issue). The net profit, before taxation, for the six months to 30th September last is approximately £194,000 (against £191,000).

Yarrow & Co., Ltd., report that after providing £280,000 for taxation, the group net profit for the year to 30th June last is £315,646, as compared with £199,518 for the preceding year. The dividend for the year is 17½ per cent on capital increased by a one-for-four scrip issue (against 14 per cent equivalent).

Richard Johnson & Nephew, Ltd., have declared an interim dividend of 3½ per cent (against 2½ per cent). It is stated that the increase does not imply an increase in the total distribution for the year.

Senior Economisers, Ltd., has announced an interim dividend of 8 per cent (against the equivalent of 8½ per cent after allowing for a scrip issue).

Enfield Rolling Mills, Ltd., is paying an interim dividend of 2½ per cent (unchanged) on increased capital.

Richardsons, Westgarth & Co., Ltd., announce an interim dividend of 3½ per cent (unchanged).

Efco, Ltd., has declared an interim dividend of 5 per cent (unchanged).

New Companies

Lancashire Dynamo India, Ltd.—Registered 6th November. Capital £500. To carry on business in India and elsewhere as electrical and general engineers, etc. Directors: H. G. Carter (director of Lancashire Dynamo Holdings, Ltd., etc.), A. J. C. McLeod (director of Rustyfa, Ltd., etc.), F. F. H. Schroeder (director of Lancashire Dynamo & Crypto, Ltd., etc.) and J. H. Jamieson (director of Champdany Tube Co., Ltd.). Regd. office: St. Stephen's House, Victoria Embankment, S.W.1.

Electrical Co. (Slough), Ltd.—Registered 29th October. Capital £100. Electrical engineers and contractors, etc. Directors: L. Crisp and Mrs. Anne Crisp. Regd. office: 12, High Street, Slough, Bucks.

R. Marking & Co., Ltd.—Registered 30th October. Capital £2,000. Manufacturers of and dealers in electrical, radio, telephone, telegraph, mechanical reproduction and recording apparatus, etc. Directors: N. R. Marking and D. M. Morgan. Regd. office: 197, Streatham Road, Mitcham, Surrey.

R. V. W. Edwards & Son, Ltd.—Registered 30th October. Capital £3,000. Radio, television and electrical engineers, etc. Directors: R. V. W. Edwards, Sylvia J. Edwards, C. R. Edwards and Eileen M. Edwards. Regd. office: Wynnstay, Llandrindod Wells.

T.V. & Electrics (Notts), Ltd.—Registered 30th October. Capital £1,200. Designers, manufacturers of and dealers in household and domestic appliances, etc. Directors: M. C. Frakes, D. N. Lewis and T. A. Paling. Regd. office: 1, Downing Street, Sutton-in-Ashfield, Notts.

Alken Cleaners, Ltd.—Registered 30th October. Capital £500. Designers, manufacturers of and dealers in electrical apparatus of all kinds, etc. Directors: K. Wallis and Mrs. Dorothy O. Sharp. Regd. office: Barclays Bank Chambers, College Street, Rushden, Northants.

Everlight, Ltd.—Registered 2nd November. Capital £1,000. Manufacturers of and dealers in electric lamps, etc. Directors: L. Lewis and Marjorie R. Lewis. Regd. office: 39, Partridge Avenue, Manchester, 23.

M.J.P., Ltd.—Registered 27th October. Capital £2,500. Manufacturers of and dealers in electrical goods, etc. Directors: C. H. Myhill, R. A. R. Jenner and P. G. Pope. Regd. office: 101, Main Road, Sundridge, Kent.

Belljoe, Ltd.—Registered 27th October. Capital £100. Manufacturers of and dealers in electrical goods, etc. Regd. office: 10, Kingly Street, W.1.

James Jones (Wigston), Ltd.—Registered 29th October. Capital £2,000. Electrical engineers and contractors, etc. Directors: J. Jones and R. P. Gillett. Regd. office: Granby Place, Granby Street, Leicester.

Bankruptcies

A. Roberts, lately carrying on business as an electrical and hardware dealer, under the style of Roberts Radio and Television Services at 18, Penygraig Road, Penygraig, Glam., and at Hill View Stores, Tonyrefail, Glam.—Trustee, Mr. G. H. Down, 106, Walter Road, Swansea, appointed 10th November.

E. A. Grover, lately carrying on business with another as Leyton Radiovision Co., at 156, Hoe Street, London, E.17, and lately carrying on business on his own account at 78, Leytonstone Road, London, E.15, as Leyton Radio Service, both as a radio and electrical dealer.—Receiving order made 5th November on debtor's own petition. Public examination 13th January at Bankruptcy Buildings, Carey Street, London, W.C.2.

J. R. Woods, formerly carrying on business under the name of Homelectrics, at 3, St. Mary's Road, Southampton, domestic electric appliance retailer.—Receiving order made 9th November on debtor's own petition. Public examination 20th January at the County Court, Castle Square, Southampton.

G. F. Hedger, 80, Grenville Road, Plymouth, trading as Hedger & Greenway, electrical contractor, formerly carrying on business with another at 80, Grenville Road, Plymouth.—Last day for receiving proofs for dividend 27th November. Trustee, Mr. J. E. Ellis, 50, The Terrace, Torquay.

M. J. Haine and **M. E. Simpson**, trading as Haine & Co., of 77, Westbourne Grove, London, W.2, electricians. (Separate estate of M. J. Haine).—Supplemental dividend of 2s 6¼d in the £, payable at Bankruptcy Buildings, Carey Street, London, W.C.2.

W. H. Rosindale, lately carrying on business as an electrical contractor at 12 and 14, Paragon Arcade, Paragon Street, Hull.—Trustee, Mr. S. D. Moore, 4, Silver Street, Hull, released 20th October.

J. Darwen, residing at 35, Barlow Lane, Reddish, electrical engineer, formerly carrying on business at Dane Bank House Works, Windmill Lane, Denton, Lancs., and previously carrying on business at 23, Reddish Lane, Gorton, Manchester, as an electrical contractor.—Last day for receiving proofs for dividend 1st December. Trustee, Mr. J. Tye, 20, Byrom Street, Manchester, 3, Official Receiver.

A. Moore, lately carrying on business at 5, Upper Hurst, Mount, Outlane, Huddersfield, and 12, Ray Gate, Mount, Outlane, Huddersfield, as a builder, contractor and electrician.—Last day for receiving proofs for dividend 1st December. Trustee, Mr. F. L. Kilby, 27, Bradford Road, Brighouse.

Liquidation

John Hunter & Co. (Electrl. Engrs.), Ltd. (Members' voluntary winding-up).—Particulars of claims to the liquidator, Mr. J. M. Hanmer, 1-3, Stanley Street, Liverpool, 1, by 10th December.

Institution of Production Engineers

IN the course of his speech at the annual dinner of the Institution of Production Engineers held at the Dorchester Hotel, London, on 19th November, Mr. G. R. Pryor (president) said that as production engineers they were facing an acceleration in the rate of technological progress which was quite frightening. The degree of specialisation now necessary was reflected in the greatly extended syllabus of their new examination which came into force next year. But it was abundantly clear to everyone that this progress in science and technology was not in any way matched by a similar progress in human relations. He was sure that this situation was both a challenge and an opportunity which their Institution should accept in the coming years. The production engineer, more than any other engineer, scientist or accountant, was concerned with the day-to-day management of men. He must, of course, have the other professions behind him but it was the production engineer who translated their achievements into effect through the industrial community which he controlled. If he could not do so with justice to that community, with equity and with charity, he must fail in his profession. Much that we did in the name of incentives, of production control, of quality control, and of welfare itself, was nothing but a substitute for good labour relations. These were some of the reasons why their Institution was so well worth while; why it had such a vital role to play in industry. That their members were attaining a large measure of success was apparent by the industrial achievement of the last few years and was abundant justification for their having applied for a charter of incorporation.

Computers for Research Work

Ferranti, Ltd., has received orders for two general-purpose "Pegasus" electronic computers. The first will be installed at the Road Research Laboratory of the Department of Scientific and Industrial Research where it will be used for all aspects of road research calculations; in particular, problems associated with road traffic and safety. The second has been ordered by the Steel Company of Wales and is intended primarily for research studies. The total value of both machines exceeds £150,000.

Nuclear Power Under Examination

THE building of nuclear power stations in this country is essentially a three-part effort involving the Atomic Energy Authority, the Central Electricity Generating Board and the manufacturers' consortia. The design and development of the reactors is, at present, almost wholly the responsibility of the Industrial Group of the A.E.A., and after an investigation earlier this year the Select Committee on Estimates expressed themselves satisfied with the way in which the Group carried out its tasks (see *Electrical Review*, 21st August). The Committee were concerned mainly to see that public money was being well spent, but in taking evidence they occasionally allowed themselves to stray on to more general questions affecting the future of the nuclear power programme and the possibilities of exports. This evidence is now published* and anyone with the patience to go through the 500 pages of small type will find themselves amply rewarded with fascinating detail and a unique insight into the minds of some of the people who determine the future of nuclear power in this country.

Reducing Costs

Sir Christopher Hinton, who, while he was with the A.E.A., was largely responsible for the present pattern of development, is now, as chairman of the C.E.G.B., principally concerned to buy power stations that generate electricity economically. It is not surprising, therefore, that he considers that bringing down the cost of nuclear power is the primary object of the A.E.A. in relation to the industrial programme and that he is far from happy about the extent to which the A.E.A. are prepared to guarantee the performance of the fuel elements. The economics of the nuclear power programme are based on a fuel element life of 3,000 MW-days/tonne, but there has been no experience of "burn-ups" of this magnitude. If they are not achieved the C.E.G.B.'s costs will go up accordingly and Sir Christopher thinks the A.E.A. should accept some of the responsibility.

He would also be "very relieved" if the nation suggested taking over a share of the excess cost of nuclear power over that of conventional power, though he saw little chance of its happening. Parity with the costs of electricity generated in conventional stations has now been put back five years, to 1970, principally because of the precipitate fall in the capital costs of conventional plant. Nuclear power will be needed in any case after 1970 to make up the deficit in coal needed for electricity generation. But even if the availability of coal is greater than is estimated, Sir Christopher does not "for one moment think we should drop our nuclear programme." Though not committing himself, he guessed that in the late 1960's the present trend would continue and only about 40 per cent of the new generating capacity would be nuclear powered.

*Fifth Report from the Select Committee on Estimates (United Kingdom Atomic Energy Authority), H.M. Stationery Office (price £1 7s).

His optimistic long-term views on nuclear power costs remain unchanged, but he thinks that the present trend by which capital costs have been reduced by a steep rise in reactor size will have to be retarded or halted. The C.E.G.B. want experience of these large reactors before any further appreciable increase is allowed, and think it unwise to have too many large units in the electricity system. Nevertheless, even if there is no increase in size, experience in construction should lead to further economies, though Sir Christopher does not put these at more than 10 per cent of the prices now being quoted. Although reductions in capital cost are thus not likely to bring the cost of electricity from "Calder" type reactors down to that of conventional stations, there are possibilities of improvements due to reductions in the cost of fuel elements or an increase in the plutonium credit. The latter depends on the success of the fast reactor project at Dounreay, which Sir Christopher considers to be the most important development project of the industrial group. "We shall not have a satisfactory nuclear power industry until there is a reactor that uses the by-product plutonium . . . and the fast reactor is the ideal reactor for doing this."

Advanced Gas-Cooled Reactor

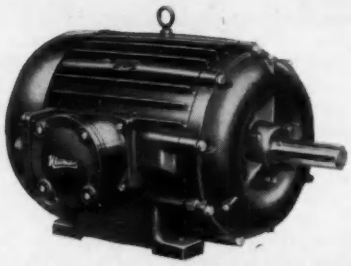
Orders placed during the next two years will still be for developments of the Calder type reactor. But it is an indication of the importance he attaches to getting costs down that he thinks the C.E.G.B. might be wise to run the risk of ordering advanced gas-cooled reactors before the A.E.A. have got operating experience of the experimental unit they are now building at Windscale. Though a bold suggestion it receives strong support. Two of the consortia specifically state that the C.E.G.B. should ask industry at an early stage, possibly next year, to tender for a commercial station based on the A.G.R. system.

For the purposes of the inquiry each consortium was asked to answer a set of 14 questions, and each managing director, and sometimes another member of the staff, was cross-examined by the Committee. This is perhaps the most intriguing part of the evidence because the differences of attitude and enterprise between the group are marked and stand clearly revealed. The basic common problem is the shortage of work or at least the need to utilise design and development resources to better advantage. As was pointed out, the tendering procedure of the C.E.G.B., whereby all the consortia quote for each station, has resulted in a very substantial loss of highly trained manpower every year.

The consortia would also like to do much more design and development work for the Atomic Energy Authority, especially on advanced types of reactor, and to be consulted earlier on the long-term development of new systems. While there is general agreement again that the policy of the A.E.A. up to now has been wise and that it is important that our nuclear resources should not be spread thinly over too many projects, the consortia all consider that a greater effort should be devoted to developing reactors of less than 100 MW for the export market. But there is less agreement on how far they could finance this themselves. With the present gas-cooled reactor, the high royalty charges of the A.E.A. and the uncertainty of fuel costs due to the absence of a burn-up guarantee are claimed to be handicaps in the export field. But it appears that with both the export orders gained so far the A.E.A. have shown some flexibility and the consortia concerned have been satisfied with the co-operation received.

Explosion-Proof Motors for America

By G. REDFERN, M.A.(Cantab.), M.I.E.E.*



Explosion-proof motor approved by American Underwriters' Laboratories for use in hazardous situations

MEETING THE REQUIREMENTS OF THE UNDERWRITERS' LABORATORIES

THE successful build-up of British electric motor exports to North America, which this year promise to reach an unprecedented level, would be impossible had not our home industry the initiative and resources to produce some of the "speciality" motors required in that market. Both the United States and Canada have vigorous and efficient electric motor industries and the United Kingdom manufacturers' future position internationally must depend to a large degree on their ability to compete on as wide a front as possible.

This policy has been pursued intensively by Newman Industries, Ltd., since its entry into North America in 1952 and despite several major setbacks, including a complete revision of the U.S. National Electrical Manufacturers' Association's standards, this company's share of the dollar market represents a major proportion of its total exports.

A notable stage in the dollar export programme was reached in March, 1957, when the company secured the approval of the official Underwriters' Laboratories, Inc., for a new range of explosion-proof motors. It is the only British company which has so far achieved this, for the specifications for American explosion-proof motors are such as to necessitate a departure from accepted United Kingdom standards.

Despite the fact that Newman Industries have been granted a certificate for their range of motors from ½ to 30 h.p., each batch of motors manufactured is subject to inspection by a United Kingdom representative of the Underwriters before the official "approved" name plate can be affixed and the motors dispatched. This inspection often extends to a dimensional check on every component of the motor plus the pulling of test bars cast from the iron used for the major components.

These motors have a major application in the United States for use in driving machinery in places where there is a fire or explosion hazard such as oil refineries, chemical works and granaries. Newman motors are now certified for Class 1, Group D, and Class 2, Groups F and G, by the Underwriters. The American classified hazardous situations are:—

Class 1, Group D.—Atmospheres containing gasoline, hexane, naphtha, benzene, butane, propane, alcohols, acetone, benzol, lacquer solvent vapours or natural gas.

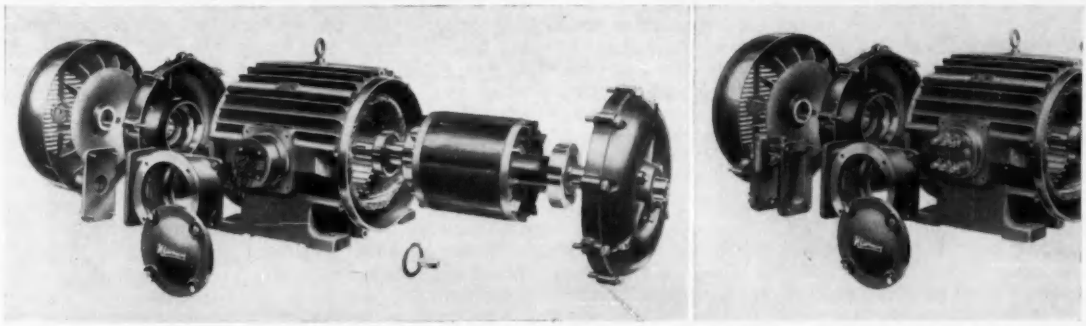
Class 2, Group F.—Atmospheres containing carbon black, coal or coke dust.

Class 2, Group G.—Atmospheres containing flour, starch or grain dusts.

The constructional requirements for American Underwriters' approval for motors for hazardous positions are similar to our own Buxton requirements for "flameproof" motors in that all joint faces are about 1in wide and the permissible gap between the faces is very small so as to provide an effective flame trap. There *are* differences, however, between Buxton and Underwriters' requirements so that generally a motor that satisfies Buxton requirements is unacceptable to the Underwriters. Newman Industries, however, have evolved a mechanical design which fully satisfies both authorities, the motor itself being identical (except that there is no Buxton equivalent for the inflammable dust groups), but alternative terminal arrangements are fitted to suit either British or American standard practice.

Of course, the motors still have to meet the appropriate electrical standards and Buxton certified motors (normally 50 c/s) comply with B.S. 2613:1957 and Underwriters' approved types (normally 60 c/s) comply with N.E.M.A. standard M.G.1. The main difference between the two types of motors is in the terminal box. While the Buxton

*Director and Chief Engineer, Newman Industries, Ltd.



Left: Exploded view of motor showing the compound-filled terminal chamber required by the Underwriters' Laboratories and screwed conduit with Briggs thread as normally used in the United States. Right: The terminal arrangements on a Buxton-certified motor which are interchangeable with the American type

certified motor has the conventional type of terminals in long, close-fitting bushes, the motor conforming to the Underwriters' requirements has loose leads passing through a compound-filled chamber. The terminal boxes are so designed that the casting which normally carries the terminals on a Buxton certified motor is mechanically interchangeable with the American compound-filled chamber.

The other difference between the two requirements concerns mainly the length of the flame paths and the permissible clearances between the mating surfaces and close-running parts. To satisfy both requirements, the feature of the two which was the most stringent was used for the design. For example, B.S. 229 states that the shaft seal length shall be at least 1in and the diametral clearance 0·016in whereas the Underwriters' Laboratories require a shaft seal 1½in long, but allow a diametral clearance of 0·025in. Newman's therefore adopted the maximum shaft seal length of 1½in and the minimum diametral clearance of 0·016in in order to meet both specifications.

The procedure for obtaining Underwriters' approval follows very closely that adopted by the Ministry of Power at Buxton. Following a preliminary examination of drawings, complete motors are submitted to exhaustive tests which include:—

(i) Holding the shaft stationary and applying full voltage, then measuring the temperature of the casing when the thermal trip in the motor switches off the current.

(ii) Enclosing the motor in a large case into which is introduced a thick haze of grain. This has a dual purpose—(a) to ensure that the grain dust does not penetrate into the motor, and (b) to ensure that the dust does not char through outside contact with the motor frame.

(iii) Three days' continuous testing with a running check constantly maintained.

When these tests have been satisfactorily completed by the Underwriters the motors are "Listed" as approved. Various materials from which the proposed range of motors is to be built are also subjected to individual tests by the Laboratories to ensure their suitability for the purpose for which they are to be used.

The certificate of approval to a manufacturer is not, in itself, the end. In addition to the individual inspection of motors before dispatch, the company also receives a yearly visit from an Underwriters' representative from the United States who checks that the routine inspection procedure is being properly followed and that the required standard of quality and accuracy is being maintained generally. There is, therefore, very close control by the Laboratories to ensure that motors bearing their approval plate fully meet their standards.

Thus the company is now able to offer a range of motors of from ½ to 30 h.p. designed electrically to meet either British or N.E.M.A. standards and dimensionally interchangeable in drip-proof, totally enclosed, flameproof (Buxton certified) or explosion-proof (Underwriters' approved) enclosures. They are built to new N.E.M.A. dimensions and are available in foot, flange and face mountings in all four types of enclosures, and all, with the exception of the Buxton certified groups, are approved by the Canadian Standards Association.

RECORD POWER CAPACITY INCREASE IN ONTARIO

LAST year 917 MW of additional generating plant was installed by the Ontario Hydro-Electric Power Commission, the greatest annual increase in the Commission's history. The new plant included the first seven units of the 940 MW Canadian section of the St. Lawrence power project, the last two units at the main power house of the Sir Adam Beck-Niagara No. 2 station, three units in the associated pumping-generating station and 163 MW of hydro-electric plant at developments in the Commission's North-West Division.

The remaining nine units at the Robert H. Saunders-St. Lawrence station are scheduled for service by the end of this year, completing the development of the last major hydro-electric scheme in Southern Ontario. Future additions to the Commission's generating plant will be mainly thermal. The capacity of the Richard L. Hearn steam station in Toronto is being increased from 800 to 1,200 MW by late 1960 and when the first two 300 MW units are in service at the new Lakeview station, to the west of metropolitan Toronto, the installed capacity of conventional thermal-electric stations will be 2,164 MW. In addition, a 20 MW nuclear power demonstration plant is being built in conjunction with Atomic Energy of Canada, Ltd.

The Commission's annual report shows that at the end of 1958 the total dependable plant capacity was 5,166 MW of which 4,548 MW was hydro. A further 595 MW was available from other sources. Water conditions were generally less favourable than in the previous year and the output of the Commission's stations, at 25,643 million kWh, was 2·2 per cent lower than in 1957 but, including purchased power (5,807 million kWh), the total showed an increase of 1·1 per cent. The industrial recession continued until the last quarter of the year and this materially affected the Commission's sales. Direct supplies to the steel, electro-metallurgical and abrasives industries contracted by 35 per cent to 1,039 million kWh and to the base metal mining industry by 15 per cent to 1,302 million kWh. Against this, the pulp and paper industry's requirements increased by over 7 per cent to 2,056 million kWh and more than twice as much electricity was used in uranium mining (591 million kWh against 250 million).

The number of consumers served by the Commission and municipal utilities at 31st December, 1958, was 1,757,000. By the end of the year a million consumers had been changed over from 25 to 60 c/s since the inception of the programme and this work has now been completed, five years ahead of the date originally scheduled.

A sales promotion department has been established by the Commission and regional staffs have been expanded to provide assistance to municipal utilities in promoting the use of electricity. Strong support is being given to the "Live Better Electrically" campaign, with particular emphasis on house heating and the benefits that will follow the future development of electrical devices for household use.

The financial section of the report shows that gross revenues amounted to $201 million and the total cost of providing the service was $198 million. Gross expenditure on fixed assets was $191 million.

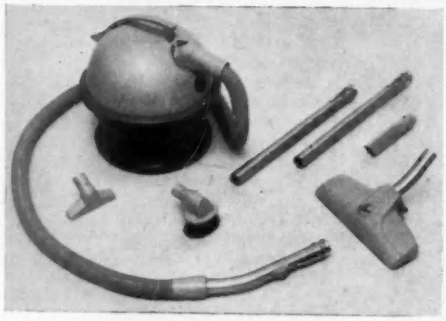
NEW ELECTRICAL EQUIPMENT

Spherical Vacuum Cleaner

A new version of the Hoover "Constellation" cleaner, to be known as model 862, has been introduced by HOOVER, LTD., Perivale, Greenford, Middlesex. Re-styled in a colour combination of pearl white and heather rose, the machine has the same spherical casing as its predecessor but the suction inlet has been offset from the top centre of the cleaner towards the front. This makes possible a more convenient form of carrying handle, a depression in the top of the machine allowing room for the fingers to be placed under the handle. This off-centre hose connection keeps the switch towards the operator.

The cleaning tools now include a carpet and floor nozzle of new design. A low height all-plastic casing houses a full length polythene backed brush which can be operated in a "float" position for the normal carpet sweeping function or locked into a low position by foot control when cleaning hard surfaces. In this housing there is also a flexible plastic strip with teeth which disturbs the litter, making it easier for the brushes and suction to deal with. A series of plastic rollers in front of the nozzle ensures the smooth movement of this accessory.

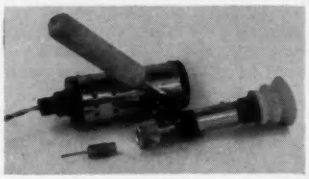
A plastic all-purpose nozzle, a dusting brush and a crevice tool are also supplied and it is equipped with double-stretch "Hooverflex" hose. To allow for the fitting and removal of a "Disposall" paper bag, and for maintenance, the cleaner is hinged in the middle. The loading is 580 W and the price, including purchase tax in the United Kingdom, is £18.



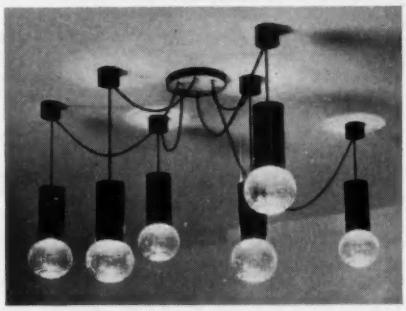
Hoover model 862 "Constellation" vacuum cleaner with cleaning tools

Internal Inspection Instrument

The latest addition to the "Inspectascope" range of optical inspection equipment manufactured by VISION ENGINEERING, LTD., Send Road, Send, Woking, Surrey, employs a high power indirect lighting system directed down an inspection probe on to the surface to be examined. The image is viewed by a scroll focus magnifying head to which a range of probes from ¼ to 1in diameter and 5 to 45in long can be fitted. The absence of a lamp at the lower end of the probe permits blind holes to be inspected radially to the full depth. The extension tubes are provided with mirrors for 90° forward and reverse oblique viewing. Mains transformers or portable rechargeable accumulator packs are available, and among the additional fittings which can be supplied is a magnifying head fitted with an adjustable graticule with which the instrument can be fitted to a standard vernier height gauge, enabling internal threads, etc., to be measured axially along the bore to an accuracy of 0·0005in.



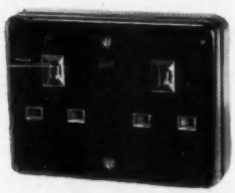
Vision Engineering internal inspection instrument



Six-unit cluster; one of the Atlas "Chelsea" hand-wrought glass lighting fittings

13 A Double Socket Outlet

A new 13 A double socket outlet designed for single box fixing has been produced by CLANG, LTD., Cricklewood, London, N.W.2. With no extra wiring it will fit into a single B.S. 1299 box and, when in position, the projection is only $1\frac{5}{16}$in. The unit can be used either for converting an existing socket or to save wiring costs in new installations where two outlets are desirable. The overall dimensions are $4\frac{1}{16}$in by $3\frac{1}{4}$in. The construction is of moulded bakelite and the prices, per dozen, are £4 10s (brown) and £4 17s 6d (ivory).



Clang 13 A double socket outlet

Decorative Lighting Fittings

With the introduction of their "Chelsea" range of hand-wrought glass lighting fittings ATLAS LIGHTING, LTD., Thorn House, Upper St. Martin's Lane, London, W.C.2, have entered the decorative lighting field. The glass units, of English make, are in seven basic shapes and six colours and each is interchangeable. They are held in position by a metal spider assembly, within a slim black cylinder. The lamp, a silvered reflector 60 W mushroom type, is also encased within the cylinder and, when lit, has the effect of illuminating the glass without revealing the light source.

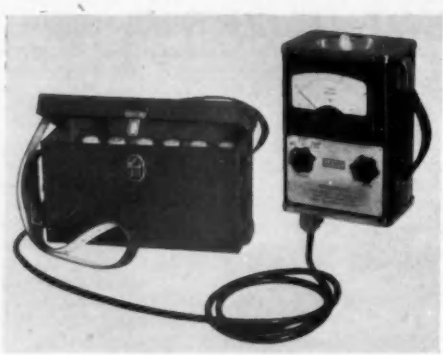
The basic fitting is suspended on a glossy black flex from the ceiling on a matt black plate with an aluminium disc centre. The disc is self-adhesive and when pressed in position conceals the fixing screws. Larger ceiling plates are available which will take two or more fittings and when a cluster is desired the flex leads can be looped from this centre plate to scattered suspension points.

Battery-Operated Stroboscope

A transistorised stroboscope which can be powered by any 12 V d.c. source capable of supplying 1 A has been introduced by DAWE INSTRUMENTS, LTD., 99, Uxbridge Road, London, W.5. In the type 1211 "Stropack" a pulse output is produced from the d.c. source by a multivibrator circuit, the repetition rate being controlled by a potentiometer through a slow-motion drive from the front panel. After differentiation and amplification, the output from the multi-vibrator circuit is fed to a step-up transformer to provide a high-voltage pulse to trigger the flash tube. The neon-filled tube has a flash duration of 15 μsec giving sharp images at all speeds.

The output from the multi-vibrator also operates a frequency meter circuit, the 3·2in scale of the meter being calibrated directly in r.p.m. Flash rates between 600 and 15,000 per minute are covered in two ranges, speeds higher than 15,000 r.p.m. being measured by flashing only once in two or more revolutions. The accuracy is ±2 per cent of full-scale deflection.

The new "Stropack" measures



Dawe battery-operated stroboscope

5¼ by 3½ by 7⅞in and weighs 3¾ lb, and the 12 V battery weighs 9¼ lb and measures 9½ by 5½ by 4in. The transistorised circuits enable one battery charge to operate the stroboscope for eight hours continuously.

Hotpoint Refrigerators

Two 1960 refrigerators have been announced by A.E.I.-HOTPOINT, LTD., 33, Grosvenor Place, London, S.W.1, the E.37 and E.50 Super "Iced Diamond." Both models, 3·7 and 5 cu ft respectively, have the latest clean-cut, squared-off lines and can be obtained with either right- or left-hand door opening. For smaller kitchens, the E.37 model can be free standing, built under an existing work surface or placed chest high in a line of kitchen units. In the last-mentioned position the escutcheon plate and handle are in a convenient lowered position.

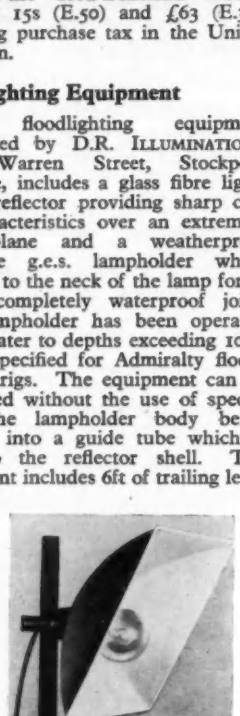
The contemporary lines of the new models have made possible the planning of maximum interior storage space in relation to their outside dimensions. The E.37 occupies floor space 21in square and the E.50 24in square. There is more room in the inner door panel than in the company's previous models. The butter compartment with its removable dish is new and there is ample room for eggs, milk and tall bottles. A separate cheese compartment is provided in the larger model. The cabinets have an inner liner of white polystyrene and each is fitted with an interior light. Also new is the deep wide salad bin which has now been fitted at the bottom of the cabinets. The rollers for easy movement introduced last year on Hotpoint refrigerators have been retained.

Both models are available in white or cream stoved enamel with coloured vitreous enamelled table tops in white, cream, red, blue or green. The vitreous enamelled table top is standard on the E.50 but the standard E.37 has a stove enamelled top. If this model is to be free standing, the addition of a vitreous enamel top (£3 3s extra) is recommended. The prices of the "Iced Diamond" models are £78 15s (E.50) and £63 (E.37), including purchase tax in the United Kingdom.

Model E.50 Super "Iced Diamond" refrigerator (A.E.I.-Hotpoint, Ltd.)

Floodlighting Equipment

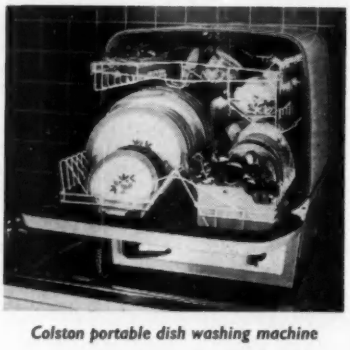
The floodlighting equipment announced by D.R. ILLUMINATIONS, LTD., Warren Street, Stockport, Cheshire, includes a glass fibre lightweight reflector providing sharp cut-off characteristics over an extremely wide plane and a weatherproof neoprene g.e.s. lampholder which seals on to the neck of the lamp forming a completely waterproof joint. This lampholder has been operated under water to depths exceeding 100ft and is specified for Admiralty floodlighting rigs. The equipment can be assembled without the use of special tools, the lampholder body being inserted into a guide tube which is fixed to the reflector shell. The equipment includes 6ft of trailing lead, a 13 A waterproof coupler and a standard 3in scaffold clamp, and a 500, 750 or 1,000 W lamp may be used.



D.R. Illuminations floodlight

Portable Dish Washing Machine

The first domestic electrical appliance to be manufactured by CHARLES COLSTON, LTD., 7-11, Lexington Street, London, W.1—a dish washing machine—was announced last week. Measuring only 24in high by 21in wide by 17in deep, it has been designed to fit easily on a draining board. No plumbing is necessary, the water supply being provided by means of a rubber hose connected to the kitchen tap. The machine is capable of dealing with up to 24 plates and saucers and 12 cups or glasses, cutlery, etc., at one time—the normal washing-up from a meal for four or five persons—and is fully automatic in operation. During each washing cycle the contents are washed once, rinsed twice and then dried. It is provided with a double filtering system which traps particles of food and prevents them from being re-circulated during the washing process. In the event of its drop-down loading door being inadvertently opened whilst the machine is operating, an automatic device switches off the machine. The heater (3 kW loading) will also switch off if there is an insufficient supply of water.



Colston portable dish washing machine

The inside racks of the machine are specially coated to cushion the contents and are designed to slide in and out to facilitate loading. The casing of the machine, both inside and outside, is vitreous enamelled and the exterior finish is in white, trimmed in grey.

The running costs are claimed to be very low, only one gallon of water being used during each operation, but the action of a jet accelerator is said to produce the effect of water at the rate of 60 gal/min. Because of its built-in heating elements the machine can be used from either a hot or cold water supply. The price, including purchase tax in the United Kingdom, is £89 5s.

Miniature Pull Switch

A 1 A miniature cord pull switch suitable for modern wall and ceiling fittings has been marketed by CASTELCO (GREAT BRITAIN), LTD., Castle Works, High Street, Old Woking, Surrey. It is an alternative q.m. and b. single-pole switch suitable for use on 250 V or low voltage. It can be supplied with either screwed terminals or solder tags and is available in nine colours. The price per dozen, with 1ft of white nylon cord, is £1 4s.

PARLIAMENTARY REPORT

IN a written question, Miss J. Lee asked if the President of the Board of Trade had considered evidence sent to him that monopoly pressures in the cable industry threatened to stifle fair competition and to expose the public to unduly high prices.

Mr. Erroll, Minister of State, Board of Trade, replied "I am aware that there is at present keen competition in the electric cable industry, that prices have fallen and, indeed, that some manufacturers complain that prices are below cost. We are watching the position. We certainly have no ground for assuming that manufacturers are likely to charge unduly high prices in future. We have power to refer these matters to the Monopolies Commission, but do not think it would help to do that now."

Interference with Television

A complaint that the erection of pylons, overhead lines, and high-voltage switching devices in the area of Bridgend, Newburn and Newcastle-on-Tyne was causing interference with television reception was made by Mr. Woof. He asked the Home Secretary to make representations to the Central Electricity Generating Board. Mr. Butler said the district was screened by high ground from the television transmitters serving the area. This meant the received signal was weak and particularly liable to interference from overhead power lines and associated equipment.

The C.E.G.B. had been asked to help and it had recently completed arrangements which had greatly improved the conditions.

Pollution from Poole

The danger to health arising from the fall-out of oil smuts from Poole power station was referred to by Captain Pilkington when he asked the Minister of Housing and Local Government what consultations he was having with the Electricity Authority about the matter. Sir Keith Joseph, Parliamentary Secretary, said the Chief Alkali Inspector had for some time been consulting with the Central Electricity Generating Board on this problem of oily smuts. The Board had put further work in hand at Poole to reduce the nuisance and a complete answer was being urgently sought by research.

Canada and Nuclear Research

Replying to a question on the United Kingdom's relations with Canada in matters affecting research and development in the field of atomic energy, Sir David Eccles, Minister of Education (representing the Minister for Science), said there had always been the closest co-operation with Canada. Mr. Woodburn said that an agreement had recently been signed between Canada and Euratom from which Britain seemed to be excluded.

Sir David said that Britain already had an agreement with Euratom. He was not aware the Canadians had one on any different footing.

Heat Insulation of Buildings

A new model by-law providing for higher standards of thermal insulation of domestic buildings has been prepared and the Minister of Housing and Local Government will shortly be recommending local authorities to adopt it. Stating this in the House of Commons, Sir Keith Joseph, Parliamentary Secretary, said the by-law had been prepared in consultation with the local authority associations and the professional and trade bodies who were normally consulted on these matters.

Mr. Nabarro asked if the Minister was satisfied that an optional model by-law was adequate in these matters. The Scots were much more enlightened, he said, and in the Building (Scotland) Act a minimum standard was prescribed. Sir Keith said the question of central regulations was still under consideration. Mr. Nabarro was rightly concerned with "U" values of thermal transmission coefficient, and it might interest him to know that the new model by-laws provided more stringent conditions than those laid down centrally in Scotland.

Disposal of Radioactive Waste

The Radioactive Substance Bill to regulate the keeping and use of radioactive material, and to make provision as to the disposal and accumulation of radioactive waste and for the purposes connected with these matters, has been read a first time in the House of Lords.

Automatic Telephone Exchanges

During the second reading of the Post Office and Telegraph (Money) Bill the Postmaster General, Mr. J. R. Bevins, said that quite a significant part of the capital expenditure on telephones would go on mechanisation—about £25 million. This involved completing the mechanisation of local exchanges. At present 5,000 out of the 6,000 exchanges were automatic and the Post Office planned to complete the conversion by 1970. In the end subscribers throughout the country would be able to dial not only their own local calls, but also their own trunk calls.

Cable Communications

In association with Cable & Wireless, Ltd., the Post Office was taking a big part in the further and rapid development of international communications. In 1961 a submarine telephone cable was to be laid between Canada and the United Kingdom, which would be of a larger capacity than the present transatlantic cable. It would be a single cable of new design carrying traffic in both directions. Two-way repeaters which would be used throughout were the result of Post Office development. The cable would be the first part of a wider plan for a Commonwealth round-the-world telephone cable system.

Northfleet-Canterbury Line

Criticism of the proposed route of the Central Electricity Generating Board's overhead line from Northfleet to Canterbury was made by Mr. Skeffington, who wanted to know why the former Minister of Power had rejected the suggestion that the line should be carried instead through Chatham Dockyard. The Minister of Power, Mr. R. Wood, said such a route would have cost more and taken longer to construct. An overhead line by the approved southern route of 41 miles would take about 12 months to construct and cost just under £1 million, he said. Practicable northern alternatives, although over two miles shorter, would take two or three times as long to construct and would cost at least £500,000 more.

Mr. Skeffington said that inspectors from the Ministries of Power and Housing had disagreed as to the merits of the proposed line, and seven bodies were opposed to it as it would spoil the last remaining beauty spot on the North Downs. Mr. Wood replied that he could not give any promise to reconsider the decision his predecessor came to.

Energy "Quotas" Refused

Mr. Harold Neal asked the Minister of Power whether, in view of the decline in the consumption of coal, he would introduce legislation to impose quotas on the energy industries of the country to ensure that the production target fixed by the National Coal Board would not exceed demand in 1960. Mr. Wood replied that he would not.

Damages for Injured Electrician

At Liverpool Assizes last week Mr. George Done, an electrician, was awarded £12,500 damages against the Air Ministry in respect of serious injuries sustained by him while working at the Burtonwood (Lancs.) air base. For Mr. Done it was stated that he was working on a switch panel in a power house. It had been rendered "dead" but by somebody's negligence the power was restored while Mr. Done was still there. He received very severe burns, as a result of which he had been operated on eighteen times, losing his right forearm and the use of his left hand.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 6d each including postage) are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2

1953

23887. Postmaster General.—Pulse transmission systems. 19th October, 1955. (824481.)

1954

26404. Young, S. G.—Electric lampholders. 3rd November, 1955. (824641.)

27872. Aron Electricity Meter, Ltd.—Toggle mechanisms. 28th December, 1955. (Cognate application 36370, 15th December, 1954.) (824561.)

36987. Electric & Musical Industries, Ltd.—Apparatus for reproducing colour television pictures. 22nd December, 1955. (824761.)

1955

1132. Henley's Telegraph Works Co., Ltd., W. T., and Fry, F. H.—Apparatus for measuring the length of filamentary bodies, such as cables. 13th January, 1956. (824482.)

2555. British Thomson-Houston Co., Ltd.—Controllable gas-filled electric-discharge devices of the thyratron type. 18th January, 1956. (824762.)

5479. British Thomson-Houston Co., Ltd.—Thermo-nuclear apparatus. 9th February, 1956. (824765.)

17619. British Broadcasting Corporation.—Transformers for use in circuits employing negative feedback. 12th June, 1956. (824647.)

17818. National Research Development Corporation.—Electron optical systems. 12th June, 1956. (824648.)

32034. Philco Corporation.—Electrolytic treatment of semiconductive bodies. 9th November, 1955. (Addition to 805291.) (824484.)

1956

2659. Yardney International Corporation.—Alkaline electric cells or batteries. 26th January, 1956. (824775.)

3960. Crompton Parkinson, Ltd.—Electric cables and a method and apparatus for extruding cores for electric cables. 4th February, 1957. (824657.)

7690. Sunbeam Corporation.—Electric heating and cooking device. 12th March, 1956. (824776.)

13534. Igranic Electric Co., Ltd.—Electrical controllers. 2nd May, 1956. (824779.)

14847. National Research Development Corporation.—Electron optical devices. 8th May, 1957. (824665.)

20901. General Electric Co.—Magnetisation of magnetic materials. 5th July, 1956. (824667.)

26417. Metropolitan-Vickers Electrical Co., Ltd.—Automatic traffic signalling systems. 29th August, 1957. (824781.)

27160. Vyzkumny Ustav Pre Mechanizaciu a Automatizaciu.—Arrangements for the automatic control of electro-erosive machines. 5th September, 1956. (824679.)

30197. M-O Valve Co., Ltd.—Electric discharge devices. 3rd October, 1957. (824784.)

35128. General Electric Co., Ltd.—Piezo-electric elements and electric circuits using such elements. 6th November, 1957. (824786.)

36954. Telefonaktiebolaget L. M. Ericsson.—Electronic telephone exchanges. 3rd December, 1956. (824685.)

37193. British Thomson-Houston Co., Ltd.—Automatic control of feeding movements. 13th November, 1957. (824788.)

38226. Horstmann Gear Co., Ltd.—Electric time switches. 27th November, 1957. (824687.)

1957

4414. Mullard, Ltd.—Logical circuits. 31st December, 1957. (824791.)

4622. Demarkles, L. R., Teixeira, N. A., and Chin, F. K.—Electric plug and method of manufacturing same. 11th February, 1957. (824693.)

9509. Standard Telephones & Cables, Ltd.—Constant attenuation electric cable. 22nd March, 1957. (824799.)

11023. Telephone Manufacturing Co., Ltd.—Electromagnetic relays. 1st April, 1958. (Cognate application 26976, 27th August, 1957.) (824410.)

12942. British Insulated Callender's Cables, Ltd.—Section insulators for use in overhead conductors of electric traction systems. 23rd April, 1958. (824415.)

13067. Siegel, H., and Adise, H. H.—Voltage divider calibrating apparatus. 24th April, 1957. (824416.)

14851. Sturmey-Archer Gears, Ltd.—Magneto-electric generator. 8th May, 1958. (824721.)

15247. Schloemann A.G.—Tube extrusion or cable sheathing press. 14th May, 1957. (824042.)

17684. Cohen, E., and Roth, S.—Electromagnetic couplings, particularly eddy-current slip-couplings. 4th June, 1957. (824047.)

18652. Compagnie Générale de Télégraphie sans Fil.—Ion sources. 13th June, 1957. (824728.)

22168. Machlett Laboratories, Inc.—Electron discharge devices. 12th July, 1957. (824055.)

23639. Lodge-Cottrell, Ltd.—Electrostatic precipitators. 22nd July, 1958. (824058.)

24548. Elektro-Mechanik G.m.b.H.—Electro-hydraulic actuating devices. 2nd August, 1957. (824736.)

25328. Libbey-Owens-Ford Glass Co.—Method of making an electrically conducting glass structure. 12th August, 1957. (824450.)

26733. Telefonaktiebolaget L. M. Ericsson.—Method of and a device for eliminating spurious information in a signal transmission system. 23rd August, 1957. (824065.)

28712. Schoeller & Co., E.—Method of connecting the ends of thin paper yarn suitable for the telephone cable industry. 11th September, 1957. (824742.)

29414. Telefonaktiebolaget L. M. Ericsson.—Circuits for selecting the first member in a predetermined multi-stage sequence of members. 18th September, 1957. (824466.)

30332. Standard Telephones & Cables, Ltd.—System for the automatic supervision of the production by machines. 27th September, 1957. (824069.)

30362. Western Electric Co., Inc.—A.c. signal transmission circuits. 27th September, 1957. (824745.)

31582. Autophon A.G.—Telephone substation including pre-setting means for multiple symbol combinations. 9th October, 1957. (824469.)

32345. Philips Electrical Industries, Ltd.—Ferro-magnetic ferrite materials. 16th October, 1957. (824072.)

33259. Schloemann A.G.—Extruded tubes and cable sheaths. 24th October, 1957. (824472.)

33864. General Electric Co.—Control system. 30th October, 1957. (824145.)

38376. Western Electric Co., Inc.—Ferro-electric crystal matrices and calling subscribers telephone station identification apparatus in which such matrices are used. 10th December, 1957. (824753.)

38554. General Electric Co., Ltd.—Telephone apparatus. 12th December, 1957. (Divided out of 824235.) (Addition to 743024.) (824236.)

40024. Compagnie Générale de Télégraphie sans Fil.—M-type backward wave oscillator arrangements. 24th December, 1957. (824591.)

1958

2966. Philips Electrical Industries, Ltd.—Welding electrodes. 29th January, 1958. (824539.)

3401. Mochi, E. G.—Sealing of electrical components. 3rd February, 1958. (824828.)

4330. Sulzer Freres S.A.—Nuclear reactors. 10th February, 1958. (824829.)

6442. United-Carr Fastener Corporation.—Electrical lamp socket assemblies. 27th February, 1958. (824158.)

TRADE MARK APPLICATIONS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 11th December:—

Duomat. No. 790,111. Class 7. Power-operated domestic washing machines and laundry drying machines.—Wilkins & Mitchell, Ltd., The Green, Darlaston, Staffs.

Mofex. No. 792,377. Class 7. Electrically driven shears.—E. Warsitz, trading as Maschinenfabrik Hilden Erich Warsitz, Hilden/Rhein, Germany. Address for service, c/o H. D. Fitzpatrick & Co., 94, Hope Street, Glasgow, C.2.

Lemco. No. 785,788. Class 9. Capacitors and resistances.—London Electrical Manufacturing Co., Ltd., Beavor Lane, Hammersmith, London, W.6.

Mullard. No. B789,741. Class 9. Electric discharge tubes (not for lighting purposes); and electric semiconducting devices.—Mullard, Ltd., Mullard House, Torrington Place, London, W.C.1.

Corrucontrol. No. 790,833. Class 9. Covered electric wire and cables; and electric conduits.—Wandleside Cable Works, Ltd., 106, Garratt Lane, Wandsworth, London, S.W.18.

Synchroprinter. No. 786,886. Class 9. Electrical apparatus for reproducing sound from magnetic recordings and for duplicating such recordings on to prepared media.—Tokyo Denki Kagaku Kogyo Kabushiki Kaisha, Tokyo, Japan. Address for service, c/o R. G. C. Jenkins & Co., 1, Quality Court, Chancery Lane, London, W.C.2.

Viewline. No. 791,204. Class 9. Television and radio apparatus and instruments.—Viewline (Sales), Ltd., 79, Eccleston Square, London, S.W.1.

Bambino. No. 792,301. Class 9. Electric batteries, cells, accumulators, radio receivers, television apparatus, gramophones, etc.; cases for electric torches.—Berec Radio, Ltd., Hercules Place, Holloway, London, N.7.

Multipac. No. 782,401. Class 11. Boilers (not parts of machines).—John Thompson, Ltd., Ettingshall Engineering Works, Wolverhampton.

Pretty Face. No. 789,475. Class 11. Heated towel rails.—Barton Electric, Ltd., 1524, Ashton Old Road, Manchester, 11.

Lixit. No. 785,311. Class 17. Thermal, acoustic and electrical insulating materials having a magnesite base and being treated with preservatives against termites, all being goods in block or slab form for use in building.—E. W. Morgan, trading as Luxit, Hart's Field, Westland Green, Little Hadham, Herts.

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged

MONDAY, 30th NOVEMBER

Guildford.—Prince of Wales Hotel, Woodbridge Road, 7.30 p.m. A.S.E.E. Aldershot and District Branch. "Temperature Control," by J. A. Taylor.

London.—Charing Cross Hotel, W.C.2, 11 a.m. Institute of Metal Finishing. Annual general meeting followed by luncheon and (at 2.45 p.m.) induction of Mr. A. A. B. Harvey as the new president, and presidential address on "The Role of the Scientific Society."

TUESDAY, 1st DECEMBER

Bradford.—Institute of Technology, 6.30 p.m. I.E.E. North Midland Centre. "A System for the Automatic Recognition of Patterns," by Dr. R. L. Grimsdale, Dr. F. W. Sumner, Dr. C. J. Tunis and Dr. T. Kilburn.

Edinburgh.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. South East Scotland Sub-Centre. "Future Generation and Transmission Development in Scotland," by J. Henderson.

Hammersmith.—Windsor Castle Hotel, 134, King Street, 7.30 p.m. A.S.E.E. West London Branch. "Electric Clocks," by D. Burgess.

Hull.—Yorkshire Electricity Board, Ferensway, 6.30 p.m. I.E.S. Hull Centre. "Fifty Years of Lighting Development," by J. W. Powell.

Ightham.—George and Dragon, 7.30 p.m. A.S.E.E. West Kent Branch. Film "Electrical Shop Window of 1959."

Leicester.—Westcotes Constitutional Club, 7.30 p.m. A.S.E.E. Nottingham Branch. Film evening.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Measurement and Electronics Sections. "Frequency Variations of Quartz Oscillators and the Earth's Rotation in Terms of the N.P.L. Caesium Standard," by Dr. L. Essen, J. V. L. Parry and J. McA. Steele.

Manchester.—Engineers' Club, 17, Albert Square, 7 p.m. I.E.E. North Western Centre. "Resurrectionists and Fellow Travellers," by Prof. G. A. G. Mitchell.

Newcastle-upon-Tyne. — Crown Hotel, Clayton Street, 7.30 p.m. A.S.E.E. Newcastle-upon-Tyne and District Branch. "Space Travel."

Peterborough.—White Lion Hotel, Church Street, 7.30 p.m. Institution of Plant Engineers, Peterborough Branch. "Automatic Control using Computers for Machine Tools," by M. Monk. (Joint meeting with the Institution of Production Engineers.)

Reading.—Marquis of Lorne, Friar Street, 7 p.m. A.S.E.E. Reading and District Branch. "Life as an Airline Pilot," by Captain M. C. L. Carter.

Sheffield.—City Hall, 7.30 p.m. I.E.E. Sheffield Sub-Centre. Faraday Lecture. "Electrical Machines," by Prof. M. G. Say.

Southampton.—Polygon Hotel, 7.15 p.m. Institution of Production Engineers, Southern Region. "Materials Handling," by R. G. Winton.

WEDNESDAY, 2nd DECEMBER

Birmingham.—James Watt Memorial Institute, Great Charles Street, 7 p.m. Junior Institution of Engineers, Midland Section. Presidential address, by A. Russell.

Cheltenham.—Belle Vue Hotel, 7.30 p.m. Society of Instrument Technology, Cheltenham Section. Films on Transistors.

Edinburgh.—Y.M.C.A. Social Room, 14, South St. Andrew Street, 6.15 p.m. I.E.S. Edinburgh Centre. "New Data for Calculation of Coefficients of Utilisation," by W. Robinson.

Glasgow.—At the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, 6 p.m. I.E.S. South West Scotland Sub-Centre. "Future Generation and Transmission Development in Scotland," by J. Henderson.

Halifax.—Crown Hotel, Horton Street, 7.45 p.m. A.S.E.E. Halifax Branch. "Telecommunications in the Modern Age," by L. F. Reynolds.

Hove.—South Eastern Electricity Board Offices, 6.30 p.m. I.E.E. Southern Centre. "The Provision of Adequate Electrical Installations in Buildings—(a) Houses, by C. C. Hyams, (b) Multi-Storey Flats and Maisonnettes," by C. A. Belcher.

Leeds.—Electrical Engineering Department, Leeds University, 6.30 p.m. I.E.E. North Midland Education Discussion Circle. Discussion on "The Teaching Approach to the Part III Candidate," opened by Dr. E. C. Walton. (Joint meeting with Graduate and Student Section.)

London.—I.E.E. London Graduate and Student Section, 9.30 p.m. Visit to Associated Newspapers, Ltd., E.C.4.

London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, 6 p.m. British Institution of Radio Engineers. Annual general meeting, followed (at 7.15 p.m.) by an address by president, Prof. E. E. Zepler.

Middlesbrough.—Cleveland Scientific and Technical Institution, 6.30 p.m. I.E.E. Tees-Side Sub-Centre. "Subscriber Trunk Dialling," by D. A. Barron.

Newcastle-upon-Tyne.—Room B7, Percy Buildings, Kings College, Queen Victoria Road, 6.15 p.m. I.E.S. Newcastle-upon-Tyne Centre. Symposium of Present-Day Commercial Lighting.

Preston.—R.A.F.A. Club, East View, 7.30 p.m. A.S.E.E. Preston Branch. "Control Centres for Modern Industry," by K. W. Liller.

Rugby.—College of Engineering Technology, 6.30 p.m. I.E.E. Rugby Sub-Centre. "A System for the Automatic Recognition of Patterns," by Dr. R. L. Grimsdale.

Treforest.—Glamorgan College of Technology, 6.30 p.m. British Institution of Radio Engineers, South Wales Section. Chairman's address. "Wastage in Technical Education," by J. Cotterell.

Wood Green.—Civic Centre, Town Hall, 8 p.m. A.S.E.E. North London Branch. "Protective Equipment for Industrial Plant," by Dr. W. L. Stern.

THURSDAY, 3rd DECEMBER

Cardiff.—I.E.S. Cardiff Centre. Chairman's address, by A. J. Dalton.

Chelmsford.—Crompton Parkinson, Ltd., Social Hall, 7.30 p.m. Chelmsford Engineering Society. "Space Heating by means of Electrically Warmed Floors," by L. Shepherd.

Glasgow.—29, St. Vincent Place, 6.30 p.m. I.E.S. Glasgow Centre. "New Data for Calculation of Coefficients of Utilisation," by W. Robinson.

London.—Savoy Place, W.C.2, 5.30 p.m. Institution of Electrical Engineers. Ordinary meeting. "The Transmission of News Film over the Transatlantic Cable," by C. B. B. Wood and I. J. Shelley.

At the Royal Institution, Albemarle Street, W. Institution of Plant Engineers, London Branch. "An Introduction to Electronic Data Processing," by Dr. H. A. Thomas.

Northampton.—Grand Hotel, 7 p.m. I.E.E. Rugby Graduate and Student Section. District meeting. "Nuclear Power Reactor Control," by J. A. Darke.

Nottingham.—Albert Hall, 7 p.m. I.E.E. East Midlands Centre. Faraday Lecture. "Electrical Machines," by Prof. M. G. Say.

Sheffield.—Grand Hotel. Institution of Plant Engineers, Sheffield Branch. Dinner-dance.

FRIDAY, 4th DECEMBER

Birmingham.—Midland Institute, Paradise Street, 6.30 p.m. I.E.E. South Midland Centre. "The Jodrell Bank Radio Telescope," by H. C. Husband. (Joint meeting with I.C.E. and I.Mech.E.)

Cardiff.—Grand Hotel. A.S.E.E. South Wales Branch. Annual dinner.

Fawley.—Administration Building, Esso Refinery, 5.30 p.m. Society of Instrument Technology, Fawley Section. "Remote Supervisory Control and Plant Monitoring," by L. S. James.

Liverpool. — Industrial Development Centre, Paradise Street, 7.30 p.m. A.S.E.E. Liverpool and District Branch. "Fire Protection," by J. R. Moyle.

London.—Savoy Place, W.C.2, 6 p.m. I.E.E. Medical Electronics Discussion Group. Discussion on "Nuclear Magnetic Resonance," opened by Dr. N. Sheppard and Dr. R. E. Richards.

14, Rochester Row, Westminster, S.W.1, 7 p.m. Junior Institution of Engineers. Film evening. "Nickel Matters," "The Problem of Creep in Metals" and "Spheroidal Graphite Cast Iron."

SATURDAY, 5th DECEMBER

London.—I.E.E. London Graduate and Student Section, 10 a.m. Visit to Odeon Theatre, Leicester Square, W.C.2 (projection and sound equipment).

Café Royal, W.1, 6 for 6.30 p.m. Institute of Metal Finishing, London Branch. Annual dinner and dance.

Porthcawl.—Seabank Hotel. Institution of Plant Engineers, South Wales Branch. Dinner-dance.

Formica Chart

A new reference chart has been produced by Formica, Ltd. It measures 13½in by 18½in and is designed for wall hanging. Neat and colourful in approach it conveys all the essential information about each of the 22 grades of laminate produced by the company. On the front it includes small samples of each grade with a summary of its qualities, together with a chart of grade characteristics to enable users of this material to see at a glance which combination of characteristics applies to each grade. On the reverse side there are details of the average physical properties of industrial laminates when tested in accordance with British Standard Specifications. Applications for the chart should be made to the Industrial Sales Department, Formica, Ltd., 84-86, Regent Street, London, W.1.

A.S.E.E. Programme

The Association of Supervising Electrical Engineers has issued to members an attractive booklet bound in leatherette containing details of all A.S.E.E. national events, as well as particulars of the branch lectures and social events which are taking place throughout the United Kingdom. The Association will be glad to give a copy, free of charge, to anyone making application to the general secretary of the Association at 23, Bloomsbury Square, London, W.C.1.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Australia.—State Electricity Commission of Victoria, Melbourne. 9th December. 66 kV switchgear and accessories. (E.S.B. 27122/59. Ten/43404.)*

Canada.—Manitoba Hydro-Electric Board, Winnipeg. 17th December. Supervisory control equipment for the St. Vital Road terminal station. (E.S.B. 26856/59. Ten/43422.)* 22nd December. Mobile coal handling plant. (E.S.B. 27070/59. Ten/43397.)*

Co. Down.—Welfare Committee. 10th December. Electrical installation in old people's home, Hillsborough. J. R. W. Murland, consulting engineer, 13, Wellington Place, Belfast.

Health Committee. 9th December. Electric lighting installation in new child health clinic and library, Gilnahirk. Barrett & Agnew, consulting engineers, 420, Ravenhill Road, Belfast.

Honduras.—Empresa Nacional de Energia Electrica, Tegucigalpa. 15th December. Power circuit-breakers. (E.S.B. 27322/59. Ten/43480.)*

Huddersfield.—Corporation. 14th December. Time switches. (See this issue.)

India.—Delhi Electricity Department. 7th December. 192 distribution transformers, ranging from 25 kVA to 750 kVA. (E.S.B. 27221/59. Ten/43424.)*

Iraq.—Director of Contracts and Purchases, Ministry of Defence, Baghdad. 7th December. Electricity meters, signal generators and variable resistances. (E.S.B. 27309/59. Ten/43487.)*

Malaya.—Central Electricity Board. 28th March, 1960. Switchgear for Cameron Highlands scheme. (See this issue.)

New Zealand.—Dunedin Electricity Department. 5th January. 33 kV and pilot cables. (E.S.B. 27109/59. Ten/43415.)*

Norway.—H.Q. Allied Forces Northern Europe, Kolsas. 20th December. Radio valves. (E.S.B. 27009/59. Ten/43355.)*

Pakistan.—Water and Power Development Authority, Lahore. 10th December. E.h.v. switchgear, busbars and steel structures for Lahore Kotlakhpat grid station. (E.S.B. 27101/59. I.C.A. Ten/43391.)* 15th December. Equipment for Peshawar grid station control room. (E.S.B. 27387/59 I.C.A. Ten/43481.)*

Rhodesia and Nyasaland.—Bulawayo Electricity Department. 6th January. Cable, wire, terminals and clamps. (E.S.B. 26854/59. Ten/43344.)*

South Africa. — Union Tender Board, Pretoria. 17th December. Twenty rectifiers. (E.S.B. 27324/59. Ten/43462.)*

Sudan.—Controller of Stores, Sudan Railways, Atbara. 21st December. Electrical installation at the new Grand Hotel. (E.S.B. 27118/59. Ten/43401.)*

Posts and Telegraphs Department, Khartoum. 26th January. Underground polythene telephone cable. (E.S.B. 27222/59. Ten/43428.)*

Turkey.—H.Q. Allied Land Forces South Eastern Europe, Izmair. 7th December. Cable. (E.S.B. 27342/59. Ten/43452.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

United States.—Bureau of Reclamation, Denver, Colorado. 8th December. 230 kV control board sections and carrier current transmitter/receiver sets for Huron substation. (E.S.B. 27557/59. Ten/43509.)*

ORDERS PLACED

Darlington.—Education Committee. Electrical work at a new workshop block at the College of Further Education (£3,256).—James Paterson & Co.

London.—L.C.C. Two electric passenger lifts at Battersea College of Technology (£7,088).—Express Lift Co. Electric water heaters, Becontree estate (£10,143) and Downham estate (£12,124).—F. J. Baynes & Co. Electrical installation, Lee Manor County Secondary School, Lewisham (£3,207).—Reid & Barrow. Renewal and improvement of electrical installations, Loraine estate, Islington (£12,621).—Jenkins Electrical. Renewal and improvement of electrical installation, Sir William Collins, Robert Louis Stevenson and St. Richard of Chichester Schools, St. Pancras (£6,069).—Powis Electrical Co.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Barnard Castle.—Factory and offices, Gainford, for J. J. Robinson & Son; J. Stobart, builder, Billy Row, Crook, Co. Durham.

Blackpool.—Offices, Preston New Road and Cherry Tree Road; Telefusion, Ltd., 76, Buchanan Street.

Works, Clifton Road; James Pye, Ltd., Orders Lane, Kirkham.

Blaydon (Co. Durham).—Factory, Chain Bridge Road, for Valley Plastic Coaters, Ltd.; Wetherell, Lamb & Partners, architects, 24, Picton Place, Newcastle-on-Tyne.

Factory extensions; Churchill Gear Machines, Ltd.

Bridgend.—Extensions to the General Hospital (£566,000); Architects' Division, Maesycoed Road, Rhiwbina, Cardiff.

Bristol.—Four-storey offices, Queen Square; Alfred F. French & Partners, architects, Halifax House.

Carlisle.—Block of residential flats, London Road; Border Engineering Contractors, Ltd., Queen Street, Whitehaven.

Cheltenham.—Works extensions; Taylor Young (Printers), Ltd., Clarence Street.

Coventry.—Studios and offices, Aston Cross, for Alpha Television Services; W. S. Hattrell & Partners, architects, 1, Queens Road.

Fifteen-storey business and residential block, Market Way; A. G. Ling, city architect, Bull Yard, off Warwick Row.

Croydon.—Supermarket, Surrey Street; Cater Bros., Ltd., 35, Treby Street, E.3.

Eleven-storey office block, High Street and Fell Road; Graham & Denis Crump, architects, 43, George Street.

Dwellings (111), New Addington; Gee, Walker & Slater, Ltd., 100, Park Lane, W.1.

Darlington.—Factory additions (10,000 sq ft), Aycliffe trading estate; J. V. Spencer, architect, 171, Albert Road, Middlesbrough.

Denby Dale.—Bungalows (45); Joseph Berry & Sons, architects, 5, Market Walk, Huddersfield.

Dudley.—Factory, Cradley Road, Netherton; John Barnsley & Sons, Ltd., Netherton.

Essex.—Secondary school at Rochford, infants' school at Rayleigh, and adaptations and extensions to Rayleigh Secondary School (£130,000); H. Conolly, county architect, County Hall, Chelmsford.

Grimsby.—Swimming baths, Scarthoe Road (electrical installation £15,000); borough architect.

Hatfield Hyde.—Erection of residential block at Welwyn/Hatfield New Hospital, Howlands; regional architect to Hospital Board, 40, Eastbourne Terrace, London, W.2.

Herts. — Secondary modern school, Cheshunt, and primary and infants' schools at Welwyn Garden City; C. H. Aslin, county architect, County Hall, Hertford.

Ilford.—Two 11-storey blocks of flats, Oaks Lane and The Glade; borough engineer.

Leicester.—Works, Jerrom Street; Arthur Gee & Co., Ltd., Southgate Street.

Lichfield.—Shops (55), supermarket, motel, etc., Greenhill area (£500,000); Shingler & Risdon, architects, 47, Bedford Road, London, W.C.1.

London.—Additions to Battersea Training College of Domestic Science; George Fairweather, architect, 28, Wigmore Street, W.1.

Dwellings (64), Studley Road, Clapham; Sir Lancelot Keay, architect, 22, Oldbury Place, W.1.

New buildings for Tollington Park School, Marriott Road, Islington; Demolition & Construction Co., Ltd., 3, St. James's Square, S.W.1.

Mablethorpe.—Hall and cafeteria in central amusement park for Mablethorpe and Sutton-on-Sea U.D.C. (£17,000); Council's architect.

Maidstone.—Flats (160), Park Wood estate; H. Richardson & Sons, Ltd., Slade Green Road, Erith.

Newcastle-on-Tyne.—Blocks of 10-storey flats in Montagu Avenue; Cussins, Ltd., builders, The Drive, Gosforth.

Houses on 207-acre site at Hill Heads, Newburn; J. T. Bell & Sons, builders, Market Street Chambers, Newcastle.

Peterborough.—Nurses' home, Memorial Hospital; Guy Aldis, architect, 33, Parkside, Cambridge.

Ripon.—Factory, Bondgate; Glovers of Ripon, Ltd., Low Skellgate.

St. Pauls Cray.—Factory for Algraphy, Ltd., Peckham; Lavender McMillan, Ltd., Cheam Common Road, Worcester Park.

South Shields.—Office block for Harton Dyeworks, Ltd., and garage and showroom for Dunns Garages, Ltd.; Page, Son & Hill, architects, 75, King Street, South Shields.

Stanmore.—Church of St. William of York; Professor Corfiato, architect, 15, Woburn Square, London, W.C.1.

Stockton-on-Tees.—Five-storey office block for Aycliffe Properties, Ltd., Newton Aycliffe; Thornton & Rangley, architects, 26, Station Road, Redcar.

Sunderland.—Conversion of Monkwearmouth Grammar School into College of Further Education (£200,000); borough architect, Grange House, Stockton Road.

Houses (253), Town End Farm estate; L. W. Evans, Ltd., builders, Norfolk Street, Sunderland.

Truro.—New area hospital at Treliske; Adams, Holden & Pearson, architects to Hospital Board, 38, Gordon Square, London, W.C.1.

Walsall.—Houses (640), shops and public buildings as development of Lower Farm estate; M. E. Habershon, borough engineer, Council House.

West Hartlepool.—Old people's hostel, Owton Manor estate (£43,000); G. M. Pearson & Son, builders, Front Street, Hetton.

Winchester.—Houses (500), Harestock Lane; Bendall Developments, Ltd., Friary House, St. Michael's Road.